



## GLOSSARY

**Scales** are referred to as follows :—

- ( i ) *for scales which are multiples of 1/1,000,000—“1/M scale”, “1/6 M scale”, &c., which mean “1,000,000 scale”, “1/6,000,000 scale”, &c.,*
- ( ii ) *for scales smaller than 4 miles to one inch—“50-mile scale”, “8-mile scale”, &c., which mean “scale of 50 miles to one inch”, “scale of 8 miles to one inch”, &c.,*
- ( iii ) *for scales of and larger than 4 miles to one inch—“1-inch scale”, “½-inch scale”, “4-inch scale”, “16-inch scale”, &c., which mean “scale of 1-inch to one mile”, &c., &c.,*
- ( iv ) *other scales, by their representative fraction, e.g., “1/25,000”.*

### **Serial Numbering of Survey of India maps**

Sheets NE-43, NF-44, &c., are sheets on 1/M scale; ( International Numbering ).  
Sheets 65, 78, &c., are sheets on the 1/M scale; ( now superseded by above ).  
Sheets 65 K, 78 F, &c. are ½-inch sheets;  
Sheets 65 K/N.W., 78 F/S.E., &c., are ¼-inch sheets;  
Sheets 65 K/1, 78 F/16, &c., are 1-inch sheets.

The system of numbering is fully explained in the Indexes at the end of this report.

**Abbreviations**—U.S.S. denotes Upper Subordinate Service.

G.C.S. denotes General Central Service.

U.S. Officer denotes Upper Subordinate Officer.

L.S. Officer denotes Lower Subordinate Officer.

H.L.O. denotes Hathibarkala Litho Office ( Dehra Dūn ).

P.L.O. denotes Photo-Litho Office ( Calcutta ).

P.Z.O. denotes Photo-Zinco Office ( Dehra Dūn ).

D.O. denotes Drawing Office.

M.R.I.O. denotes Map Record and Issue Office.

A.I.D. denotes All-India Development.

I.C.A.O. denotes International Civil Air Organization.

## PART III. GEODETIC WORK

	Page
XI. ABSTRACT OF GEODETIC OPERATIONS ..	76
XII. SURVEY REPORTS, SURVEY RESEARCH INSTITUTE (GEODETIC BRANCH FROM 1-11-48 )	
Summary .. .. .	79
Computing and Tidal Party .. .. .	79
Computing Office .. .. .	79
Observatory Section .. .. .	81
Tidal Section .. .. .	82

## ILLUSTRATIONS

Group photograph taken after Senior Officers' Conference in Delhi—February 1948 .. .. .	Frontispiece
A 'C' type Officers' Residence on the Survey of India Estate, Dehra Dūn .. .. .	9
Survey Vehicle being ferried across the Mahanada River..	40
An aerial view of the Damodar River .. .. .	46
The entrance to the Map Publication Offices, Dehra Dūn..	58
Printing Presses at the Map Publication Offices, Dehra Dūn	62
A view of the Machine Room of the Photo-Litho Office, Dehra Dūn .. .. .	70

## INDEX MAPS

A. Modern Topographical surveys and compilation ..	At end
B. Modern Topographical surveys and revision by 10-year periods from 1905 .. .. .	At end
C. Index showing Project surveys in hand .. .. .	At end
D. Maps published on scales of 1-inch and $\frac{1}{2}$ -inch to one mile .. .. .	At end
E. Maps published on scales of $\frac{1}{4}$ -inch to one mile .. .. .	At end
F. Carte Internationale du Monde, 1/M scale .. .. .	At end
G. Southern Asia Series, 1/2M scale .. .. .	At end

The Magnetic survey :

Observation of the direction and force of gravity :

Astronomical observations to determine latitude, longitude and time ;

Seismographic and meteorological observations at Dehra Dūn.

Indian geodesy has disclosed widespread anomalies in the gravitational attraction in the earth's crust which have recently led to a reconsideration of the whole theory of isostasy. Systematic gravity investigations, which may be said to have been initiated in India by the Survey of India, are now being carried out intensively in all civilized countries.

**Topographical Surveys.**—In the past this department used to carry out the large scale revenue surveys for most of India, and was still conducting this work for Central and Eastern India and Burma in 1905.

Though revenue survey is primarily a record of individual property boundaries and is unconcerned with the surface features, ground levels and exact geographical position essential to a topographical survey, it was on the whole found economical to carry out both surveys together.

By 1905, however, the small scale topographical surveys compiled from the large scale revenue maps had fallen seriously in arrears, owing to the relatively slower pace and incompleteness of the latter, on which non-revenue-paying areas are normally shown blank.

An authoritative Survey Committee appointed by the Government of India considered the position in 1905. It was feared that a separation of the topographical and revenue surveys might result in a wasteful duplication of work and two overlapping but mutually discrepant systems of mapping. These objections were met by a ruling that the basis of both systems of survey should be identical and provided either by the Survey of India or under its supervision.

Subject to this principle, the remaining revenue surveys were handed over to the provinces, which had always paid for them as part of the overhead charges of revenue collection, and the Survey of India was enabled to concentrate its energies on a complete new series of modern topographical maps in several colours on the 1-inch to 1-mile scale.

This new series had been rendered necessary by the natural demand for more detailed information to be shown on maps, especially as regards the portrayal of hill features by contours and proper classification of communications.

It was intended that the survey begun in 1905 should be completed in twenty-five years, and then revised periodically every thirty years. Owing, however, to the 1914-19 war and more recent retrenchments, only about three fourths of the programme had been

**Air Survey.**—The use of air photographs for survey purposes has become a normal practice and air survey is employed wherever it is considered advantageous to do so. The Survey of India has arranged with a company in India for the supply, on contract rates, of such photographs as it may require for survey purposes.

Air photographs in pairs for stereoscopic examination or made up in the form of mosaics are very often of value in inspecting sites prior to undertaking detailed survey operations, or may sometimes render these unnecessary. Any demands for air photographs or mosaics should be forwarded to the office of the Surveyor General in Mussoorie or to one of the Circle Directors who will give quotations.

It may be noted that under the orders of the Government of India all demands for air photography from departments of the Central Government must be placed through the Survey of India.

**Military requirements.**—Prior to the 1939-45 war, the Survey of India was responsible for all survey operations required by the Army. During the war, a Military Survey Service was formed and this Service is likely to be retained by the Army in peacetime as a permanent measure. This arrangement will relieve the Survey of India of a considerable amount of responsibility for work for the Army, but as the Military Survey Service is likely always to be small, the Survey of India will still be called upon to do a large amount of map production for military purposes.

**Civil Aviation.**—With the establishment of an International Civil Aviation Organization, charts on varying scales to a uniform specification have been planned to cover the whole world. The production responsibility for these charts has, generally speaking, been allotted to the country whose territories cover the part of the globe concerned. In the case of India our commitments are :—

- ( i ) Charts on the 1 : 1,000,000 scale—23 in number.
- ( ii ) Instrument Approach Charts on the scale 1 : 250,000, and Landing Charts on the scale of 1 : 50,000 of all the important Civil Aerodromes in the country. These are printed back-to-back, and are about seventy-two in number.
- ( iii ) Besides the above, charts on the 1 : 500,000 and 1 : 250,000 scales, Route Charts and various Plotting and Planning Charts are planned, but the limits of responsibility and the final implications of these have not yet been settled.

The production of these various series of I.C.A.O. Charts is a new responsibility of this department.

**Administration.**—The administration of the Survey of India was in the hands of the Surveyor General of India under the Ministry of Agriculture. The headquarters office of the Surveyor General of India was in the Old Secretariat at Delhi and was under the administration of the Deputy Surveyor General. A technical office was



The Technical Report, arranged in three parts, on the lines of the General Report, contains figures for areas, out-turns and cost rates of surveys (including air surveys), details of surveys, and technical methods. This technical report is intended for departmental use as well as for distribution to other survey and scientific departments.

Part III of the Technical Report which deals with the geodetic and geophysical activities of the department in detail, is published as a separate volume.

There is also a supplement to the Technical Report for departmental use. This Supplement, as its name implies, is merely to supply details which are of little general interest, but which are required departmentally to record the output of individuals. It will not be printed.

The General Report and Technical Reports only deal with maps and surveys of areas where the maps are unrestricted. Particulars of surveys and maps which are "Restricted" for security purposes are given in a confidential supplement to the General Report which is a restricted document. The first issue of this since the war covering the period from 15th August 1947 to 31st March 1949 is under publication.

The progress of modern (i.e., since 1905) topographical surveys made by the department and of compilations made from our own or other material is illustrated in *Index A* at the end of this report, while *Index B* indicates the obsolescence of modern surveys. *Index C* shows project surveys in hand and the remaining *Indexes D, E, F* and *G* show all the standard maps which have been published up-to-date on various scales. It will be seen from *Index D* that the areas within India which are blank on *Index A* are actually almost entirely covered by topographical maps. These maps are, however, prepared from material based on the old longitude of 1815, which was over 2 miles in error, are mostly uncontroled, are drawn in the old style and are many years out of date; they are consequently excluded from *Index A*.

It may be mentioned here that besides the standard maps shown in *Indexes D, E, F* and *G*, this department also publishes aeronautical maps on the 1/M scale of an area covering India and adjacent countries, Landing and Approach Charts on scales of 1/50,000 and 1/250,000 respectively for all civil aerodromes in India. Province maps on 1/M scale, Town Guide maps varying from 3 inches to 16 inches to one mile, maps of India on scales of 40, 70, 128 and 192 miles to an inch, special maps like Railway maps of India, Road maps of India, as well as Town maps and Cantonment maps from special surveys.

2. Surveyor General's Office.—BRIGADIER G. F. HEANEY, C.B.E., held the post of the Surveyor General of India throughout the period under report except for a period of four months on leave from 26th May to 28th September 1948, when MAJOR (L/BRIGADIER) I. H. R. WILSON, officiated in his place.

( b ) *British Military Officers*.—The British Treasury agreed to the payment of lump sum compensation to British Military Officers in the Survey of India, who decided to leave India either on retirement or reversion to British Service as the result of the constitutional changes. The majority of the British Military Officers of the Survey of India, proceeded on leave either preparatory to retirement or pending reversion to the Home establishment, within a few months of the introduction of the constitutional changes.

( c ) *Revised Pay Rules*.—The Central Civil Services ( Revision of Pay ) Rules 1947 for personnel of the Survey of India were published in the Gazette of India dated the 20th December 1947.

The main feature of these rules is the large increase in pay granted to Class IV personnel ( *khalāsis*, etc. ). This has with subsequent amendments greatly added to the cost of field work.

( d ) *Reorganization of Military Survey Services*.—The Government of India has approved of the Surveyor General of India being in technical charge of the Military Survey Service, as Director of Military Survey, in addition to his other duties, provided he is a military officer.

The post of the Director, Military Circle, was abolished from 30th February 1948 and in lieu a purely military post of Deputy Director of Survey, carrying the rank of full Colonel, was sanctioned.

The post of Assistant Director, Military Circle had been abolished with effect from the 15th August 1947.

( e ) *Changes in Names and Designations*.—The Government of India approved of the following changes in designations of appointments in the Survey of India :—

( i ) *New Names for Circles*.—The following changes in the names of the Geodetic Branch and the Survey Research Institute were introduced with effect from the 1st November 1948 :—

----- Geodetic Branch—changed to Northern Circle.

Survey Research Institute—changed to Geodetic Branch.

( ii ) *Designations of Class I and II Officers, Sub-Assistant Superintendents, Topographical Assistants* :—

Old Designation	New Designation
<i>Class I Service</i>	
Superintendent.	Superintending Surveyor.
Assistant Superintendent.	Deputy Superintending Surveyor.
<i>Class II Service</i>	
Extra-Assistant Superintendent.	Officer Surveyor.
<i>Class III Service</i>	
Sub-Assistant Superintendent and Topographical Assistant.	Surveyor.
Air Surveyor.	Air Survey Draftsman.
Surveyor.	Plane-tableer.



## Designation of posts

Number on 31-3-49

Permanent Temporary

## I. FIXED ESTABLISHMENT—(concl'd.)

## (c) Class III Service—(concl'd.)

## (ii) Ministerial:

Office Superintendents ..	3	1
Head Assistants ..	2	..
Assistants in Charge ..	..	3
Assistants ..	10	14
Stenographers ..	1	1
Clerks, 2nd Division ..	13	11
Clerks, 3rd Division ..	8	25

## II. UNFIXED ESTABLISHMENTS—Class III

## (i) Technical:

Surveyors (Topographical Assistants and Temporary Computers) ..	..	96
Technical Supervisor ..	1	..
Head Mechanic, Map Mounting Estt. ..	1	..
Plane-tableing and drawing personnel including Recordkeepers ..	282	624
Reproduction personnel ..	121	315
Head Artificer and Asstt. Head Artificer ..	2	..
Other Artificers ..	..	13
Bookbinder ..	1	..
Motor Drivers ..	1	55
Compounders ..	1	2
Head Packers and Asstt. Head Packers ..	..	2

## (ii) Ministerial:

Office Superintendents ..	6*	1
Head Clerks and Head Accountants ..	12*	1
Clerks, Storekeepers and Telephone Operators ..	80	220

(g) *Revival of the Post of Registrar.*—The post of Registrar in the Surveyor General's Office which was in abeyance since November 1940 was revived from 1st May 1948 and Mr. P. N. BANERJI, M.A., B.L., was appointed to it in an officiating capacity.

## 5. Raising, Transfer and Disbandment of Units.—

*No. 17 Party.*—A new party designated No. 17 Party was formed with effect from the 15th August 1947 for the training of Class III Division II personnel and was placed under the administrative control of the Director, Southern Circle, with its headquarters at Bangalore.

*No. 14 Party.*—No. 14 Party was transferred from the administrative control of the Director, Geodetic Branch (now Northern Circle) to that of the Director, Map Publication, with effect from the 15th August 1947. It was again transferred to the administrative control of the Director, Geodetic Branch, with effect from the 1st January 1948.

\* 1 post in abeyance.

7. **Deputations.**—MR. A. K. SEN GUPTA, Officiating Superintending Surveyor, Survey of India, on deputation by the Government of India, attended as a delegate to the International Civil Aviation Organization Conference ( Map Division ) held at Brussels ( Belgium ) from the 8th March 1948.

MESSRS. J. E. DAVID, Officer Surveyor and L. R. HOWARD, Surveyor, on deputation by the Government of India proceeded to Karachi ( Pakistan ) by air on the 30th July 1948 to collect India's share of map stocks, originals and other essential stores.

MR. B. L. GULATEE, M.A. ( CANTAB. ), President, Survey Research Institute, on deputation by the Government of India attended as a delegate, the Conference of the International Union of Geodesy and Geophysics held at Oslo ( Norway ) from the 19th August 1948.

MESSRS. G. B. DAS and V. KRISHNAMURTHY, Officer Surveyors, proceeded to U.K. in October 1948 to undergo a one-year course of advanced training in air survey and photogrammetry at University College, London.

8. **Conferences and Meetings.**—A Conference was held at the West Bengal Secretariat, Calcutta, on the 4th April 1948 in which unanimous decision was reached about the survey methods to be employed for fixing the East-West Bengal boundary. The conference was presided over by the Chief Secretary, Government of West Bengal, and attended by other officials of the Government of West Bengal including the Hon'ble Member, Board of Revenue and the Director of Land Records, as well as the Surveyor General of India, the Director, Eastern Circle and MR. N. L. GUPTA, a survey officer on special duty.

Between 16th and 21st May 1948, MAJOR R. C. A. EDGE, M.B.E., R.E., Deputy Director General, Survey of Pakistan, on deputation from the Government of Pakistan, discussed with the Surveyor General of India, the question of the joint survey of East-West Bengal boundary by India and Pakistan. Joint proposals by the Surveyor General of India and the Director General, Survey of Pakistan were later submitted to the Government of India by the Surveyor General.

9. **Distinguished Visitors.**—MR. K. W. P. MARAR, I.C.S., Joint Secretary to the Government of India, Ministry of Agriculture, visited the Survey of India offices at Dehra Dūn on the 22nd December 1947, and inspected the offices accompanied by the Surveyor General.

MR. B. R. SEN, I.C.S., Secretary to the Government of India, Ministry of Agriculture, visited the Survey of India offices at Calcutta, on the 1st January 1948 and was shown the work of the different branches of the department.

MR. K. W. P. MARAR, I.C.S., Joint Secretary to the Government of India, Ministry of Agriculture, visited the Survey of India offices at Bangalore on the 2nd February 1948.



who was engaged on plane-tableing work in the mountains of Nepāl, involving climbing up to 18,800 feet on the Lunak glacier.

The Supreme Allied Commander, S.E.A.C., issued a Good Service Card to EX-SUBEDAR C. S. ANANTHAN NAIK.

**11. Miscellaneous.—(a) Communal Disturbances.**—Serious communal disturbances broke out in Delhi and Dehra Dūn during the second week of September 1947. Fortunately there were no casualties among the Survey of India personnel.

**(b) Loss from Cyclone.**—A cyclone struck the field headquarters of No. 9 Party at Forbesganj (Bihār) on the 10th May 1948 and resulted in the loss of Government stores worth about Rs. 4,000.

**(c) Technical Papers.**—The Surveyor General decided to introduce a new series of papers which will be known as technical papers, and may cover either technical or administrative subjects. These papers which will be published under the names of their writers will, it is hoped, stimulate thought and encourage original research on departmental matters and will give wide publicity to them in the Department. They will normally be fairly short and will have the same status as professional and departmental papers. Publication of which will be continued as required.

The following papers were published in this series :—

*Technical Paper No. 1.*

“Towards a National Survey”.

*Author.*—BRIGADIER G. F. HEANEY, C.B.E.

*Date of Publication.*—April 1948.

*Technical Paper No. 2.*

“Value of Gravity at Dehra Dūn”.

*Author.*—MR. B. L. GULATIE, M.A. (CANTAB).

*Date of Publication.*—October 1948.

**12. Personnel.**—Retirements, casualties, promotions, appointments and other changes were as follows :—

*Retirements.*—

*Class I Officers.*—BRIGADIER E. A. GLENNIE, C.I.E., D.S.O., COLONEL O. SLATER, C.I.E., M.C., COLONEL G. W. GEMMELL, LT.-COLONEL G. BOMFORD, O.B.E., R.E., LT.-COLONEL D. R. CRONE, C.I.E., O.B.E., R.E.

*Class I (General Central Service) Officer.*—MR. D. C. VERMA.

*Class II (General Central Service) Officers.*—MR. G. J. SAHA, Assistant Head Engraver, MR. G. A. H. THOMAS, Assistant Manager.

*Class III Service.*—MR. V. D. CHOPRA, Surveyor, and other 38 employees.

*On leave preparatory to Retirement.*—

*Class I Officers.*—COLONEL G. H. OSMASTON, M.C., COLONEL J. B. P. ANGWIN, M.B.E., LT.-COLONEL H. W. WRIGHT, O.B.E., R.E., LT.-COLONEL C. A. K. WILSON, O.B.E., R.E., MAJOR R. H. SAMS, R.E., MAJOR C. A. BIDDLE, R.E.

*Confirmation in Appointments.—*

*Class I Officers.*—MAJOR J. S. PAINTAL, R.I.E., MESSRS. J. C. BERRY, T. M. C. ALEXANDER, B. N. MURTHY, M. D. NANGIA, M. R. NAIR, C. T. HURLEY, P. A. THOMAS, F. M. HAWLEY, K. L. DHAWAN, M. M. GANAPATHY, K. C. GOSAIN, E. R. WILSON, J. C. ROSS—confirmed as Superintending Surveyors.

MESSRS. P. S. SHINGHAL, N. L. GUPTA, H. H. PHILLIPS, L. J. BAGNALL, N. D. JOSHI, S. C. CHATTERJEE, A. K. SEN GUPTA—confirmed as Deputy Superintending Surveyors.

*Appointments.—*

*Class I Officers.*—T/LT.-COL. P. D. JOSHI, T/MAJOR D. N. SHARMA, T/MAJOR C. M. SAHNI, T/MAJOR R. C. TYAGI appointed as Deputy Superintending Surveyors ( on probation ).

MR. N. C. NATH—appointed as Superintending Surveyor.

*Class I ( G.C.S. ) Officers.—*

MR. L. H. MORDUE—appointed as Chief Manager, Map Reproduction.

MR. O. P. GROVER—appointed as Mathematical Adviser ( on probation ).

MR. N. T. WADHWANI—appointed as Stores Officer ( Temporary ).

MR. C. G. GEHANI—appointed as Deputy Stores Officer ( Temporary ).

*Class II Officers.*—MESSRS. R. B. LALL, M. N. KUTTY, MAHINDER SINGH, A. C. CHAWLA, G. N. DUBEY, I. C. DEV, J. C. SEN GUPTA, B. K. SATPATHY, S. P. BANERJEE, S. R. MARIA LOUIS, K. VENKATARAMAN, P. RAMAMOORTHY, H. K. CHOPRA, T. C. JYOTI, B. S. RATTAN—appointed against permanent vacancies as Officer Surveyors.

MESSRS. A. C. DEX, I. R. VISWANATHAN, C. M. SAPRU—appointed as probationers in the Class II Service.

*Class II ( G.C.S. ) Officers.*—MESSRS. C. V. HAYMAN, P. N. KIRPAL—appointed as Managers, Map Reproduction.

MESSRS. BHAGAT SINGH, P. K. GUPTA—appointed as Assistant Managers, Map Reproduction.

MR. N. S. MUKHERJI—appointed as Officer Supervisor ( Temporary ).

MR. H. L. TEJWANI—appointed as Assistant Stores Officer ( Temporary ).

MR. P. DASGUPTA—appointed as Assistant Head Engraver.

*Termination of Re-employment.—*

*Class I Officers.*—MESSRS. J. L. SAHGAL, N. N. CHUCKERBUTTY, D. C. PURI, A. F. MURPHY, D. N. BANERJI.

*Class I ( G.C.S. ) Officer.*—MR. I. J. MENDES.

*Class II Officer.*—MR. R. N. HASTIR.

*Class II ( G.C.S. ) Officers.*—MR. J. B. LAL, MR. R. B. MATHUR.

## PART I.—TOPOGRAPHICAL AND OTHER SURVEYS

### II. ABSTRACT OF SURVEYS AND TOPOGRAPHICAL WORK

14. The following two tables indicate the progress achieved in the topographical survey programme assigned to the Department in 1905 and give details of the work done during the period under report.

*Table A* shows the area of survey completed on various scales since 1905, as well as the approximate balance which remains to complete the contoured topographical survey of India.

*Table B* shows the area revised during the period under report.

There is also a *Table C*, showing in detail the survey operations carried out during the period under report, together with their cost rates. This *Table C* is now published in the Technical Report.

It may be mentioned here that it was decided in 1905 that a completely new contoured survey should be undertaken of India on a scale of 1-inch to a mile and that the survey was to be completed in 25 years and thereafter completely revised at 25-yearly intervals. For various reasons the original programme was only about three quarters completed on the outbreak of war in 1939, and practically no topographical survey operations were carried out during the war and the pre-partition period. After the partition of India work on the original programme of surveys has been resumed and the two *Tables A* and *B* below show the progress made at the end of the period under report :—

**Table A.—Progress of Topographical Surveys in India  
since 1905**

Survey Years	1 inch and larger scales	$\frac{1}{2}$ and $\frac{1}{4}$ inch scales	$\frac{3}{4}$ and $\frac{1}{2}$ inch scales	TOTALS
	Sq. Miles	Sq. Miles	Sq. Miles	Sq. Miles
1905-45 ..	7,60,480	2,02,496	58,544	10,21,520
1945-47 ..	1,427	..	..	1,427
1947-49 ..	7,346	..	..	7,346
Totals to 1949 ..	7,69,253	2,02,496	58,544	10,30,293
Balance (Approximately) ..	*1,25,000	*23,000	*96,000	2,57,100
Total programme ..	..	..	..	†12,87,393

\* Subject to alterations on final decision on the scale of surveys to be undertaken.

† Revised figures after partition of India.

*Topographical surveys by ground methods* in Hazāribāgh district ( p. 34 ).

*Cantonment, etc., surveys for the Defence Services* of Rāingarh Cantonment and Ranchi Military Camp ( Kojatoli ) ( p. 29 ).

*City surveys* in Singhbhum district for town planning purposes ( p. 37 ).

*Levelling*.—Secondary, double and single tertiary levelling in Bhāgalpur, Darbhanga, Purnea and Santāl Parganas districts ( p. 40 ); levelling for surveys of Rāingarh Cantonment and Ranchi Military Camp ( p. 29 ).

*Topographical framework*.—Triangulation, traverse and supplementary height control in Bhāgalpur, Darbhanga, Gaya, Hazāribāgh, Monghyr, Muzaflarpur, Patna, Purnea and Santāl Parganas districts ( pp. 35, 39, 40, 43 ).

#### 18. Bombay.

*Topographical surveys by air methods* of Dharoi, Limdi, Ukāi and Vājpur Dams in Baroda and Navsāri States ( pp. 49-50 ).

*Topographical surveys by ground methods* in Belgaum, Broach, Dhārwar, North Kanara, West Khāndesh, Pāñch Mahāls and Surat districts and Baroda State ( pp. 50, 56 ).

*Cantonment, etc., surveys for the Defence Services*.—Surveys of proposed site for National War Academy Airfield at Aundh, Pawai Camp near Bombay, Lohegaon Airfield and Dehu Road Extension near Poona and A.O.P. Flight at Deolāli ( p. 29 ).

*Contoured photo mosaic* of Kāli Nadi Reservoir in North Kanara district ( p. 49 ).

*Levelling* of secondary precision in connection with Limdi Dam and Vājpur Dam surveys ( p. 50 ); high precision levelling of the lines Ratnagiri to Bombay, Kolhāpur to Ratnagiri and Kolhāpur to Karwar ( p. 80 ).

*Topographical framework*.—Triangulation for Ukāi Dam and Ukāi Reservoir ( p. 51 ).

*Training*.—Training of topographical trainees, Type B, for Division II of the Class III Service in Belgaum district ( p. 56 ).

#### 19. Delhi.

*Topographical surveys by air methods* in suburbs of Delhi ( p. 24 ).

*Topographical surveys by ground methods*.—Correction survey of Delhi and surrounding country ( p. 23 ).

*Cantonment, etc., surveys for the Defence Services*.—Surveys of P.O.L. Store at Delhi Cantonment, Red Fort, Shakur Basti Ordnance Depot ' Delhi ' and Delhi Cantonment lines ( pp. 28-29 ).

*Levelling* in suburbs of Delhi ( p. 22 ); for surveys of P.O.L. Store, Delhi Cantonment ( p. 28 ).

*Topographical framework*.—Traversing for surveys of P.O.L. Store, Delhi Cantonment ( p. 28 ).

*Topographical framework.*—Triangulation, traversing and supplementary height control in Morang, Okhaldunga, Rāmechihāp, Saptari, Sindhuli Garhi and Udaipur Garhi districts (pp. 39-41).

*Geophysical work.*—Astronomical observations at one station (p. 77).

#### 25. Orissa.

*Topographical survey by air method* in Sambalpur district and Sonapur State (p. 42).

*Levelling.*—Tertiary levelling in Bolāngir and Sambalpur districts (p. 43).

*Topographical framework.*—Triangulation, traverse and supplementary height control in Angul district, and in Athmallik, Baudh, Barāmba, Daspalla, Dhenkānāl, Jharsuguda, Keonjhar, Nuapada, Rajahmundry, Rairākhōl, Rānpur, Sonapur, Sundergarh, and Udaypur districts (pp. 44-45).

#### 26. Patialā and East Punjab States Union.

*Topographical surveys by air methods* in Patialā, Kalsia and Nalāgarh States (p. 23).

*Topographical framework.*—Triangulation and traversing in Patialā, Kalsia and Nalāgarh States (p. 23).

*Rectangulation* in Patialā State (p. 25).

#### 27. Punjab.

*Topographical survey by air methods* in Ambāla district (p. 23).

*Cantonment, etc., surveys for the Defence Services.*—Survey of Sadar Bāzār Extension in Ambāla district (p. 29).

*Topographical framework.*—Traversing in Ambāla district (p. 26); Triangulation in Ambāla and Ludhiāna districts (p. 26).

*Rectangulation* in Ambāla, Karnāl, Hissār and Ludhiāna districts (p. 25).

#### 28. Rājasthān.

*Topographical framework.*—Traversing to fix co-ordinates of communication stations at Jodhpur and Udaipur aerodromes (p. 22).

*Geophysical work.*—Measurement of the deviation of the vertical at 2 stations in Mārwar; astronomical observations at 2 stations (p. 77).

#### 29. Saurāshtra.

*Topographical surveys by air methods* of Moj Reservoir and Commanded Area in Madhya Saurāshtra division (p. 49).

*Levelling* for Moj Commanded Area survey above (p. 51).

*Topographical framework.*—Triangulation and traverse for the Moj Reservoir and Commanded Area in Madhya Saurāshtra division (p. 51).

#### 30. Travancore-Cochin.

*Topographical survey by air methods* of Poringalkuthu Reservoir in Cochin State (p. 49).



### III. SURVEY REPORTS, GEODETIC BRANCH (NORTHERN CIRCLE FROM 1-11-1948)

DIRECTOR :— { Major R. H. Sams, R.E., to 20-8-47 and again from 2-10-47 to 21-2-48.  
Col. G. W. Gemmell, I.A., from 30-8-47 to 1-10-47.  
Major Gambhir Singh, I.A., from 22-2-48 to 30-9-48.  
Mr. K. L. Dhawan (current duties), from 1-10-48 to 21-11-48.  
Mr. B. N. Saha, V.Sc., from 22-11-48.

DEPUTY DIRECTOR :—Major J. S. Paintal, R.I.E., from 8-3-48 to 30-9-48.

34. Summary.—The designation of the Geodetic Branch was changed to "Northern Circle" with effect from 1st November 1948 and with effect from the same date the "Survey Research Institute" was known as the "Geodetic Branch". The units administered by the Geodetic Branch (Northern Circle from 1-11-48) were No. 1 Party, No. 13 Party, No. 14 Party (from 1-1-48), No. 15 Party, No. 20 (Cantt.) Party, No. 2 Drawing Office, Map Record Office (up to 20-2-48), Stores Office, Surveys, Survey Training Centre (from 1-9-47 to 31-5-48), the Printing Office (up to 31-10-48) and the Photo-Zinc Office (up to 30-11-47).

#### 35. Areas Surveyed.—

- 26 square miles of 4-inch original ground survey.
- 447 square miles of 4-inch original air survey.
- 11 square miles of 10-inch original air survey.
- 9 square miles of 16-inch original air survey.
- 50.3 square miles of 16-inch original air survey (outline only).
- 2.1 square miles of 32-inch original air survey.
- 26.4 square miles of 100 feet to 1-inch original air-cum-ground survey.
- 995 square miles of 1-inch correction survey.
- 96.5 square miles of triangulation for air survey control.
- 374 linear miles of traversing for air survey control.
- 175 linear miles of tertiary levelling.
- 290.5 square miles of height control.
- 3,413 square miles of rectangulation to 100 acre in Ambāla, Hissār, Karnāl and Ludhiāna districts & Patiāla and East Punjab States Union.
- 3,531 square miles of tertiary levelling in Ambāla, Hissār and Ludhiāna districts & Patiāla and East Punjab States Union.
- 3,043 square miles of rectangulation to 3,000 acre in Ambāla, Karnāl and Ludhiāna districts & Patiāla and East Punjab States Union.

39. **Field Work.**—The field work was organized as under :—

( i ) *Delhi Development Survey.*—Mr. R. S. Chugh ( Class II ) with 9 plane-tablers completed 10·3 square miles of ground verification and contouring, vertical interval 5 feet, on the scales of 40 inches to 1 mile in an area south of Delhi and tertiary levelling of 81 linear miles for height control in an area north of Delhi.

Mr. Suresh Prasad ( Class II ) with 9 plane-tablers completed 15·4 square miles in an area north of Delhi and 0·7 square miles in an area south of Delhi of ground verification and contouring ( vertical interval 5 feet ) on the scale of 40 inches to 1 mile.

These surveys were enlarged to produce maps on a scale of 100 feet to 1 inch.

The area was undulating. The flat portions were mostly built-up or covered with fruit gardens and the remainder covered with rocky outcrops. This area is being rapidly developed.

( ii ) *Fixation of Co-ordinates of Communication Facilities in Aerodromes.*—Co-ordinates of communication facilities were fixed for Palam and Willingdon aerodromes in Delhi, and for aerodromes at Jodhpur and Udaipur.

( iii ) *Rāmanga Dam Site Survey.*—Survey of 11 square miles on 10-inch scale was carried out in Garhwāl district.

Mr. Suresh Prasad ( Class II ) with plane-tablet Bakhtawar Singh completed the planimetric and height control for air survey.

( iv ) *Patiāla State Development Survey.*—Survey of 9·5 square miles on 16-inch scale was carried out in Patiāla state.

Mr. K. B. K. Menon ( Surveyor ) provided planimetric and height control for air survey of Chail, Kandaghāt and Barog colonies.

( v ) *Rewa and Satna Town Surveys.*—Survey of 6·5 and 2·5 square miles respectively on 16-inch scale was carried out of these towns.

Mr. K. B. K. Menon ( Surveyor ) carried out 63 linear miles of traversing for control for air survey besides providing control for the preparation of a 16-inch rectified air photo-mosaic of Rewa town.

Messrs. H. K. Chopra and T. C. Jyoti ( both Class II probationers ) with Mr. Jai Kirti Singh ( Division II ) completed the ground verification and contouring ( vertical interval 10 feet ). They also carried out linear miles of tertiary levelling for the purpose of providing a network of spot heights approximately 400 feet apart.

( vi ) *Survey for proposed Agra Central Railway Station ( G.I.P. ).*—Survey of 2·1 square miles on 32-inch scale was carried out in Agra district.

Mr. Suresh Prasad ( Class II ) provided control for air survey and rectification of air photographs by traversing 19 linear miles.

towards the end of February 1949 and very little was done during the period under report.

(xii) *Karnāli River Survey in Silgarhi-Doti, Dailekh, Kailāli and Sallyāna districts of Nepāl.*—This work was required in connection with the Ghāgra Power Scheme of the U.P. Government. Preliminary reconnaissance only was started.

There were three sections at the party headquarters at Dehra Dūn throughout the field season; two drawing and air survey sections under Messrs. Govind Prasad (Surveyor) and Jai Prakash (Division I) and one computing section under Mr. A. P. Gupta (Computer).

40. *Recess Duties.*—The party was organized for the recess into 4 drawing and air survey sections under Messrs. R. S. Chugh, Ratna Singh, Govind Prasad and Arjan Dev as section officers assisted by Messrs. Sohan Singh, and Jai Prakash as assistant section officers and completed the following jobs :—

(i) *Konār Project.*—2 sheets of Konār Dam Survey on 16-inch scale, covering an area of 4.7 square miles; 2 sheets of Konār Pipe Line and 1 sheet of Konār Reservoir on 6-inch scale, covering an area of 33 square miles were completed in Hazāribāgh district. Planimetric and height control was provided by the Eastern Circle.

(ii) *Ashni River Project.*—Appliqué slip for sheet No. 3 on 4-inch scale, covering an area of 4 square miles was completed in Patiāla.

(iii) *Agra Central Railway Station Survey.*—Air survey of outline only of 3 sheets on 32-inch scale was completed.

(iv) *Rewa and Satna Town Survey.*—Outline only of 1 sheet of Satna and 2 sheets of Rewa town on 16-inch scale were completed.

(v) *Delhi Development Survey.*—Air survey of outline only of 52 sheets of the northern area and 2 sheets of the southern area (Lodi Colony) was completed on 40 feet to 1-inch scale. Drawing of 32 sheets of the southern area with 5 feet contours was completed for final printing.

(vi) *Rāmgaṅga Dam Site Survey.*—2 sheets on 10-inch scale were completed for final printing.

(vii) *Karnāli River Survey in 1949.*—Air survey of outline only of 375 square miles on 2-inch scale was completed in Nepāl.

(vii) *East Punjab Capital Site Survey.*—11 sheets on 4-inch scale were completed.

(viii) *Cattle Breeding Research Station, Jubbulpore.*—1 sheet on 4-inch scale was completed.

(ix) *Kānpur (Cawnpore) Development Survey.*—23 sheets on 16-inch scale covering an area of 50.3 square miles, were fairdrawn.

(x) *Computations.*—All computations of triangulation, traversing and levelling, carried out during the field season 1947-48, were again independently computed during recess 1948.

completed 570 square miles of tertiary levelling to 25 acres in Hissār district.

*Camp ( Levelling ).*—Mr. A. N. Malhotra ( Class III Division I ) with 17 other Class III personnel completed 694 square miles of tertiary levelling to 25 acres in Hissār district and Patiāla State.

*Triangulation.*—Mr. Dayanand ( Class III Division I ) completed 300 square miles of triangulation in Ambāla and Ludhiāna districts and Patiāla State.

*Verification Survey.*—Messrs. Dayanand and Mohan Ram ( Class III Division I ) carried out verification surveys of major detail in seven 1-inch sheets in Hissār district.

( b ) 1948-49.

*Camp ( 1 ).*—Mr. A. C. Chowla ( Class II ) with 2 Class III Division I and 15 other Class III personnel completed 724 square miles of rectangulation to 100 acres in Karnāl and Ludhiāna districts and Patiāla and East Punjab States Union.

*Camp ( 2 ).*—Mr. Amar Singh ( Class III Division I ) with 3 Class III Division I and 6 other Class III personnel completed 3,043 square miles of combined theodolite traversing and rectangulation to 3,000 acres in Ambāla, Karnāl and Ludhiāna districts and Patiāla and East Punjab States Union. The traverse computations were completed *pari passu*, by a small sub-section of this camp consisting of 5 Class III computers ( later decreased to 3 ).

*Camp ( 3 ).*—Mr. Dayanand ( Class III Division I ) with 11 other Class III personnel completed 413 square miles of rectangulation to 100 acres in Ambāla district and Patiāla and East Punjab States Union.

*Camp ( 4 ).*—Mr. A. N. Malhotra ( Class III Division I ) with one Class III Division I and 11 other Class III personnel completed 85 square miles of rectangulation to 100 acres and 1,049 square miles of tertiary levelling to 25 acres in Ambāla and Ludhiāna districts and Patiāla and East Punjab States Union. Levelling computations were carried out *pari passu*, by a small sub-section of this camp consisting of 2 Class III computers ( later increased to 3 ).

*Camp ( 5 ).*—Mr. Dial Singh ( Class III Division I ) with 14 other Class III personnel completed 713 square miles of rectangulation to 100 acres and 1,218 square miles of tertiary levelling to 25 acres in Hissār district and Patiāla and East Punjab States Union. Levelling computations were carried out *pari passu*, by a small sub-section of this camp consisting of 2 Class III computers. To enable this camp to complete its allotted area which was of the highest priority, it was reinforced in strength towards the end of the field season, by 6 class III rectangulators from Camp ( 3 ), 2 class III levellers from Camp ( 4 ) and one Class III computer from Camp ( 2 ).

Computers). During 1948-49 the strength was 1 Class II probationer, 5 Burmese Officers, 6 Class III personnel ( Temporary Computers ) and 13 Topographical Trainees, Type 'B'.

Four R.I.E. officers, on posting to the Survey of India, joined the unit during February 1949 for training.

### No. 20 ( CANTONMENT ) PARTY

*Officer in charge* :— { Mr. K. L. Dhawan, to 16-11-47.  
Mr. C. T. Hurley, from 17-11-47 to 31-10-48.  
Mr. M. D. Nangia, from 1-11-48.

50. General.—The party surveyed cantonments, and other military lands in all the Army Commands at different scales, in accordance with the programme approved by the Engineer-in-Chief and the Ministry of Defence.

The 1947-48 field season commenced on the 10th of November 1947 and closed on 24th of May 1948. The 1948-49 field season commenced on the 24th of September 1948 and closed on the 31st of May 1949, except for a few jobs that will be continued till the end of June 1949. The headquarters of the party remained at Dehra Dūn for both the field seasons 1947-48 and 1948-49.

51. Personnel.—The average strength of the party, including the Officer in charge, was one Class I officer, one Class II officer, one Upper Subordinate officer ( now Surveyor ), 3 Topographical Assistants ( now Surveyors ), 1 re-employed Upper Subordinate officer and 1 Division I, 16 plane-tablers, 6 draftsmen, 6 traversers, 4 computers, 5 clerks, 1 record-keeper, 6 topographical trainees and 1 store-keeper.

### 52. Areas Surveyed.—

4-inch survey	6,400 acres.
8-inch survey	4,385 „
16-inch survey	33,904 „
24-inch survey	230 „
64-inch survey	729 „

53. Field Work.—( a ) The field work for 1947-48 was organized as follows :—

*Camp ( 1 ).*—With headquarters at Ambāla Cantonment under Mr. Bakhshi Harnam Singh ( re-employed Upper Subordinate officer ), with 12 plane-tablers and 2 traversers, completed the detail survey of Ambāla Cantonment, Meerut Cantonment and P.O.L. Store Delhi Cantonment.

Traversing and levelling for the P.O.L. Store and traversing of a portion of Remount Depot, Bābugarh were also completed.

Three Topographical Assistants ( now Surveyors ) and one Computer ( Trig. ) were attached to the camp in March 1948 for training in large scale plane-tabling.

54. **Traversing and Levelling.**—221·9 linear miles of traversing and 109·6 linear miles of levelling were carried out during 1947-48 to provide control for various jobs completed.

826·1 linear miles of traversing and 434·1 linear miles of levelling were carried out during 1948-49 to provide control for the various jobs completed during the field season and for the future survey of Ferozepore Cantonment.

55. **Recess Duties.**—( *a* ) *Season 1947-48.*—The fair mapping was carried out by 2 sections during the recess under Messrs. Bakhshi Harnam Singh ( re-employed Upper Subordinate officer ) and P. K. Chowdhury ( Surveyor ).

Also 2 air survey training sections under Messrs. A. N. Gosain ( Class II ) and Ratna Singh ( Surveyor ), were responsible for the training of 6 officers and 10 air survey draftsmen.

Mr. O. C. Dobhal ( Computer ) was in charge of the computing section throughout at Dehra Dūn.

( *b* ) *Season 1948-49.*—Fair mapping during the recess of 1948 was carried out by 3 sections under Messrs. A. N. Gosain ( Class II ), Bakhshi Harnam Singh ( re-employed Upper Subordinate officer ) and P. K. Chowdhury ( Surveyor ).

Mr. O. C. Dobhal ( Computer ) was in charge of the computing section throughout the year at Dehra Dūn.

### STORES OFFICE, SURVEYS

*Stores Officer* :— { Mr. F. M. Hawley, to 31-10-48.  
 { Mr. T. M. C. Alexander, from 1-11-48 to 26-1-49.  
 { Mr. N. T. Wadhvani, G.C.S. Class I, from 27-1-49.

56. **General.**—The Stores Office organized in 1941 with a view to centralize all survey and reproduction stores, viz., instruments, equipment, books and forms, technical stationery as well as furniture needed by the units of the Survey of India and Military Survey Units, which were being raised for operational purposes, continued to do useful work throughout the period under report.

A system of control over certain items of reproduction stores and photographic materials was instituted to prevent the limited stocks of such stores being completely depleted. This control was operated in consultation with the Director, Map Publication.

Units, disbanding after the war, returned large quantities of stores and a 100% physical check of the quantities in hand was started to arrive at the exact position. The major part of this work was completed.

The partition of stores between the two Dominions of India and Pākistān was also implemented during the period under report and some stores were handed over to Pākistān. The handing over of the remaining continued.

#### IV. SURVEY REPORTS, EASTERN CIRCLE

DIRECTOR:—	Major R. T. L. Rogers, R.E., to 15-12-47.
	Major R. S. Kalha, I.A., from 16-12-47 to 2-1-48 (in addition to his duties as Deputy Director).
	Major I. H. R. Wilson, R.E., from 3-1-48 to 17-5-48.
	Mr. B. N. Saha, M.Sc., from 18-5-48 to 9-11-48 (in addition to his duties as Deputy Director up to 4-7-48).
	Major R. T. L. Rogers, R.E., from 10-11-48.
DEPUTY DIRECTOR:—	Mr. B. N. Saha, M.Sc., to 1-9-47 and from 21-2-48 to 4-7-48.
	Major R. S. Kalha, I.A., from 2-9-47 to 23-2-48 (in addition to his duties as Director from 16-12-47 to 2-1-48).
	Mr. C. P. E. Davenport, from 5-7-48 to 23-12-48 and from 17-2-49 to 12-3-49.
	Mr. L. J. Bagnall, from 24-12-48 to 12-1-49.
	Mr. P. A. Thomas, from 13-1-49 to 16-2-49.
	Mr. M. M. Ganapathy, B.A., from 13-3-49.

60. Summary.—The units administered by Eastern Circle were Nos. 5, 9, 11, 12 Parties. No. 10 Party (up to 9-12-47 when it was transferred to Southern Circle), Map Record and Issue Office, (up to 29-2-48 when the charge was transferred to Dehra Dun), Photo-Litho Office, No. 5 Drawing Office, and the Engraving Office. The latter three units are located in Calcutta and their annual reports will be found in Sections IX and X of this volume.

No normal topographical survey programme was carried out. All parties were employed on extra-departmental surveys for development projects such as :—

Hydro-electric, irrigation, geological investigation, town planning, river control, land reclamation, alignment of electric power lines, railway construction and barrage construction; surveys in connection with disputed portions of the East-West Bengal boundary; and Tea Garden surveys for one of the large Agency firms.

##### 61. Areas Surveyed.—

- 1200 square miles of triangulation.
- 1683 linear miles of traverse.
- 2633 square miles of supplementary height control.
- 1093 linear miles of tertiary simultaneous double levelling.
- 14007 linear miles of tertiary single levelling.
- 546 linear miles of secondary levelling.
- 146 square miles of 4-inch revision ground survey.
- 187 square miles of 4-inch verification (contour) survey.
- 8 square miles of 16-inch revision ground survey.
- 66 square miles of 1-inch original air survey.
- 12 square miles of 4-inch original air survey.
- 300 square miles of control for 4-inch air survey.
- 31 linear miles of 1·5-inch revision air survey.

65. **Personnel.**—The average field strength of the party was as follows :—

1947-48.

1 Class I officer, 6 Class II officers ( including 5 probationers ), 49 Class III personnel ( including 5 Surveyors 2 Division I ) and 6 clerks and record-keepers.

1948-49.

1 Class I officer, 2 Class II officers ( including one probationer ), 50 Class III personnel ( including 11 Surveyors and 2 Division I ) and 8 clerks and record-keepers. One Class II probationer and one Class III ( Surveyor ) joined late in March.

In addition to the above strength 10 Class III personnel ( including 2 Surveyors and 1 Division I Draftsman ) remained at party headquarters for computations, air survey and fair drawing.

66. **Areas Surveyed.**—

1947-48.

732 square miles of triangulation.  
309 linear miles of theodolite traverse.  
829 square miles of supplementary height control.  
198 linear miles of tertiary simultaneous double levelling.  
499 linear miles of tertiary single levelling.  
124 square miles of 4-inch revision ground survey.  
187 square miles of 4-inch verification ( contour ) survey.  
4.5 square miles of 16-inch revision ground survey.

1948-49.

120 square miles of triangulation.  
759 linear miles of theodolite traverse.  
365 linear miles of tertiary simultaneous double levelling.  
1,277 linear miles of tertiary single levelling.  
119 square miles of 4-inch revision air survey.  
3.1 square miles of 16-inch revision ground survey.  
1,317 square miles of verification of detail on photographs.

67. **Field Work.**—Field work was organized as follows :—

1947-48.

( a ) *Jamshedpur Town Extension.*—Mr. S. Das Gupta ( Division I Field Staff ) with 5 plane-tablers completed 4.5 square miles of 16-inch revision ground survey in Singhbhum district.

( b ) *Kopili River Flood Control Project.*—Messrs. J. C. Sen Gupta ( Class II probationer ), J. K. Chatterjee, D. P. Chatterjee and K. L. Chakraborti ( Surveyors ), 15 levellers and 7 plane-tablers assisted by



and 6-inch Konār Pipe Line Extension Survey in Hazāribāgh district.

1948-49.

( a ) *Calcutta Electrification Scheme ( Route Survey of Transmission Line )*.—Mr. A. K. Sen Gupta ( Class II ) with one leveller completed 99 linear miles of theodolite traverse and 78 linear miles of tertiary levelling in Nadia and 24 Parganas districts for fixation of points at 150 and 300 yards' intervals as pointed out in the field by the liaison officer from the department of Electricity Development, West Bengal.

( b ) *Digha Town Planning*.—Mr. K. S. Loverwell ( Division I Field Staff ) with one leveller carried out 36 linear miles of theodolite traverse, 51 linear miles of tertiary levelling and 3·1 square miles of revision survey on 16-inch scale ( with 5-foot contours ) in Midnapore district. Two plane-tables assisted him in the later part of the field season—one from mid-March and the other from mid-April.

( c ) *Dihāng Reservoir Survey*.—Orders for this survey were received late in the field season. Messrs. D. Sen, S. Ray and H. S. Iyer ( Surveyors ) were sent but could only complete 50 linear miles of theodolite traverse for planimetric and height control for 4-inch air survey due to unusually early and incessant rains from March onwards.

Messrs. A. H. Sarkar and S. K. Datta ( Surveyors ) assisted by 2 levellers carried out 120 linear miles of tertiary simultaneous double levelling for establishing bench-marks in the area.

( d ) *Ganga Bridge Project*.—Mr. K. L. Chakraborti ( Surveyor ) from 5th December, Mr. J. K. Chatterjee ( Surveyor ) from 7th February, Mr. A. K. Sen Gupta ( Class II ) from 16th March and Mr. S. P. Banerjee ( Class II probationer ) from 24th March, completed 296 linear miles of theodolite traverse and 120 square miles of triangulation for fixation of  $\frac{1}{2}$ -mile and 1-mile bank points and 3-mile *Khadir* points and 808 square miles of verification of detail on photographs. Computations of all traverse work were done in the field by one computer.

( e ) *Kopili River Flood Control Project*.—Survey of this project was divided into three camps as follows :—

*Camp ( 1 )*.—Mr. J. C. Sen Gupta ( Class II probationer ) with Messrs. D. Sen, N. K. Pal Choudhury, S. Ray, A. H. Sarkar,

## No. 9 PARTY

*Officer in charge.*—Mr. H. H. Phillips.

70. **General.**—All the surveys carried out by the party were extra-departmental jobs for the Central Waterpower, Irrigation and Navigation Commission.

The party carried out the following survey operations during the field season 1947-48 :—

Irrigation surveys, on scale 4-inch to a mile, in connection with the Kosi Project, in the Bhāgalpur and Purnea districts of Bihār and the Udaipur Garhi, Saptari and Morang districts of Nepāl.

Triangulation and large scale ground survey of the Kosi dam site in the Udaipur Garhi and Morang districts of Nepāl.

Triangulation in the Kosi Catchment area in the Udaipur Garhi, Rāmechhāp, Okhaldhunga and Sindhūli Garhi districts of Nepāl.

In addition to the above main operations, theodolite traverse and secondary levelling were done in the Darbhanga, Bhāgalpur and Purnea districts of Bihār and the Morang and Saptari districts of Nepāl ; and ground survey on scale  $\frac{1}{2}$ -inch to a mile of the 250-foot and 300-foot contours was done in the Purnea district of Bihār and the Morang district of Nepāl.

The party carried out the following survey operations in the year 1948-49 :—

Irrigation surveys on scale 4-inch to a mile in connection with the Kosi Project, in the Purnea district of Bihār and the Morang district of Nepāl.

Surveys on scale 4-inch to a mile in connection with the Ganga Barrage Scheme, in the Santāl Parganas district of Bihār and the Mālda and Murshidābād districts of West Bengal.

Survey and marking on the ground of the 1100-foot contour along the gorge of the Kosi River and its tributaries, in the Udaipur Garhi, Bhojpur, Okhaldhunga and Dhankuta districts of Nepāl.

The field headquarters of the party during both the field seasons was at Forbesganj in the Purnea district of Bihār, and its recess headquarters was at Mussoorie in the Dehra Dūn district of Uttar Pradesh.

71. **Personnel.**—The strength of the party, during the field season 1947-48, was 1 Class I officer, 2 Class II officers ( including 1 probationer ), 7 Surveyors, 1 Division II and 68 Class III personnel including 6 clerks.

The strength of the party during the field season 1948-49, was 1 Class I officer, 4 Class II officers ( including 1 Class II probationer ), 11 Surveyors, and 77 Class III personnel including 7 clerks.

72. **Area Surveyed.**—

In the field season 1947-48 :—

390 square miles of triangulation for 1-inch air survey.

0.2 square mile of triangulation for 1/1000 ground survey.

*Nepāl Triangulation.*—Messrs. Mahinder Singh ( Class II probationer ) and R. L. Sharma ( Surveyor ) completed 390 square miles of triangulation in the Udaipur Garhi, Okhaldhunga, Rāmechhāp and Sindhūli Garhi districts of Nepāl, to provide planimetric control for 1-inch air survey of a portion of the Kosi catchment area.

*Planimetric and Height Control Framework.*—Mr. S. N. Barthwal ( Surveyor ) assisted by Mr. R. L. Sharma ( Surveyor ) for the first half of the season, carried out 85·0 miles of traverse in the Darbhanga district of Bihār and the Saptari district of Nepāl, to provide the planimetric control for the air survey compilation of irrigation sheets, for the next season's Kosi Irrigation survey programme, but this work was not utilized due to alterations in the programme initiated by the indentor.

A secondary levelling detachment under Mr. K. L. Puri ( Surveyor ) carried out 194·1 miles of secondary levelling in the Darbhanga and Purnea districts of Bihār and the Morang and Saptari districts of Nepāl, to provide a framework of height control for next season's Kosi Irrigation survey programme. As in the case of traverse, a major portion of this secondary levelling was not utilized.

Field work in 1948-49 was organized as follows :—

*Camp ( 1 ).*—Mr. Mahinder Singh ( Class II ) assisted by Mr. S. N. Barthwal ( Surveyor ) with 5 plane-tablers, 15 levellers and 4 computers ( including 3 computers ) completed ground verification for air survey and "stone-laying" of  $11\frac{1}{2}$  sheets covering an area of 310·5 square miles, 98·1 miles of double tertiary levelling, 2484 miles of tertiary levelling, and computations of both the types of levelling.

*Camp ( 2 ).*—Mr. R. D. Verma ( Surveyor ) with 3 plane-tablers, 10 levellers and 3 computers completed ground verification for air survey and "stone-laying" of 9 sheets covering an area of 243 square miles, 81·7 miles of double tertiary levelling, 1944 miles of tertiary levelling and computations of both the types of levelling.

The areas of work of both the above camps fell in the Purnea district of Bihār and the Morang district of Nepāl.

*Camp ( 3 ).*—Mr. G. N. Dubey ( Class II ) with Messrs. S. K. Ghosh, N. M. Das, V. R. C. Shahane, K. R. Basu, G. A. Ferns ( all Surveyors ), 5 plane-tablers, 9 levellers and 3 computers completed 178 square miles of triangulation with its computations, 140·7 miles of traverse, 199·4 miles of double tertiary levelling, and 1650 miles of tertiary levelling with their computations, and 476·6 square miles of ground verification for air survey, in the Santāl Parganas district of Bihār and the Mālda and Murshidābād districts of West Bengal. The field work of the camp will provide material for air survey compilation and 4-inch mapping, with contouring at one-foot vertical interval, of a portion of the area of the Ganga Barrage Scheme.

2 Surveyors of the same camp carried out 60 miles of traverse on both banks of the Ganges river from a point 5 miles above



*Training.*—Mr. Mahinder Singh ( Class II ) and Messrs. S. N. Barthwal, K. L. Puri, R. L. Sharma and Avinash Chandra ( all Surveyors ) were temporarily posted to No. 15 Party ( N.C. ), during the recess, for training in air survey.

7 Computers were trained in the early part of the field season 1947-48 and 3 levellers and a record-keeper were attached to the drawing sections of the party in recess for training in draftsman-ship.

#### No. 10 PARTY

*Officer in charge:*—Mr. S. C. Chatterjee, to 9-12-48.

76. *General.*—The party was employed on 4-inch surveys in connection with the Tista Irrigation Project. Further field work on this project was suspended after the partition of India as the majority of the area fell in Pakistan. During the period under report the fair mapping of eleven 4-inch sheets was completed.

The charge of the party was transferred to Southern Circle with effect from 10th December 1948, the personnel having been absorbed into No. 11 Party.

77. *Personnel.*—The average strength of the party was 1 Class I, 4 Class II, and 66 Class III officers including clerks.

#### No. 11 PARTY

*Officer in charge:*— $\left\{ \begin{array}{l} \text{Mr. M. M. Ganapthy, B.A., to 23-8-47.} \\ \text{Mr. N. L. Gupta, from 24-8-47 to 29-11-47.} \\ \text{Mr. C. P. E. Davenport, from 30-11-47 to 1-7-48.} \\ \text{Mr. S. C. Chatterjee, from 2-7-48.} \end{array} \right.$

78. *General.*—The party completed 4-inch irrigation survey of 90 sheets of which 54 sheets have been fair-mapped. The party also completed ground survey of Hirākud Dam area on scale 1/1,000 fair-mapping of which would be taken up in the recess of 1949; height control for a portion of Bihār Mica Belt area and planimetric control for a portion of Tikkarpāra reservoir area including a portion for which height control had also been completed. The recess headquarters of the party was at Mussoorie in the year 1947 and later transferred to Rānchi in 1948 but the field headquarters of the party remained at Sambalpur during the period under report. On the 1st of December 1947 the party was strengthened by the addition of personnel of No. 10 Party, the charge of which unit was transferred to Southern Circle. This party had been employed on surveys for the Tista Irrigation Project which was suspended after the partition of India.

79. *Personnel.*—The average strength of the party during the period under report was 1 Class I, 5 Class II ( two under training ), 10 Surveyors, 17 Plane-tablers, 53 Levellers, 11 Computers, 7 Clerks and 2 Store-keepers.

80. *Area Surveyed.*—

140 square miles of triangulation.

1459 square miles of 4-inch revision air survey of detail only.

*Camp (5).*—Mr. S. N. Sanyal (Surveyor), 2 Surveyors, 6 Levellers and 2 Computers completed control for 4-inch air surveys of 300 square miles in the Tikkarpāra Reservoir area.

*Camp (6).*—Mr. M. R. Subramaniam (Surveyor), 8 Plane-tablers, 2 Levellers and 1 Computer completed ground survey of 2.65 square miles of Hirākud Dam area on scale 1:1,000.

82. *Miscellaneous.*—The health of the party was generally very satisfactory. At the beginning of each season most of the men were vaccinated. Paludrine was liberally used as a preventive to malaria. Three Class IV personnel died of various diseases and one Class III officer was struck by lightning while working in the field. He was killed instantly.

83. *Recess Duties.*—For recess 1948, the fair-mapping and computation of levelling of 43, 4-inch sheets was divided into three sections, in charge of Messrs. M. K. Chatterjee (Class II), K. Sukhrām Singh (Class II), and S. R. M. Louis (Class II).

#### NO. 12 PARTY

*Officer in charge:*—Mr. J. C. Ross.

84. *General.*—The party carried out large and small scale air surveys, together with triangulation, supplementary height control, plane-tableing, ground verification, compilation and fair-mapping for various flood control, hydro-electric, geological investigation, land reclamation, town planning, boundary delineation and railway construction projects in Assam, West Bengal, Bihār, Nepāl, Orissa and the Uttar Pradesh.

85. *Personnel.*—The average strength of the unit was 1 Class I, 3 Class II and 22 Class III officers including 4 clerks.

#### 86. Areas Surveyed.—

- 0.5 square miles of triangulation.
- 180 square miles of supplementary height control.
- 66 square miles of 1-inch original air survey.
- 31 linear miles of 1.5-inch revision air survey.
- 12 square miles of 4-inch original air survey.
- 2 square miles of 4-inch revision air survey.
- 7 square miles of 4-inch revision ground survey.
- 69 square miles of 6-inch revision air survey.
- 53 square miles of 16-inch revision air survey.
- 0.5 square miles of 16-inch revision ground survey.
- 0.6 square miles of 32-inch original air survey.

#### 87. Field Work.—

Season 1947-48—Nil.

Season 1948-49—Mr. S. Rai (Class II Probationer) carried out the following:—

0.5 square miles of triangulation in Hazāribāgh district of Bihār for the Bokāro Dam Extension survey.

7.4 square miles of 4-inch revision survey of planimetry and contours, by plane-table, in Hazāribāgh district—Bokāro Coal-field.

11.7 square miles of 4-inch original air survey of detail, contours and form-lines, in Bhojpur, Dhankuta, Morang and Udaipur Garhi districts of Nepāl-Barāhakshetra. This figure excludes compilation by this section of 2.6, 1.1 and 0.6 square miles from the Kosi Reservoir ( 4-inch ), Kosi Dam ( 32-inch ) and Kosi Dam Extension ( 32-inch ) surveys, respectively.

0.8 square mile of 6-inch revision air survey of contours only, in Hazāribāgh district, appliqué slips to Konār Pipe Line and Pipe Line Extensions surveys.

10.7 square miles of 16-inch revision air survey of detail and contours, in Hazāribāgh district—Berma-Bhāndaridah Gorge.

0.8 square mile of fair-mapping in the Darjeeling district of West Bengal—Gielkhola ( Tista High ) Dam.

Entering selected detail and heights on a 3-inch photographic mosaic of the Um Tru Reservoir.—See first item below.

The two above-mentioned sections jointly carried out the following :—

29.9 square miles of 16-inch revision air survey of detail and contours, in Hazāribāgh district of Bihār and Khāsi and Jaintiā Hills district of Assam—Konār Pipe Line Extensions and Um Tru Reservoir.

4.7 square miles of 16-inch revision air survey of contours only, in Hazāribāgh district—Konār Dam.

These sections also commenced the undermentioned surveys which had to be suspended at various stages to give place to others of higher priority :—

Bokāro Coal-field.

Deolbāri Dam.

Calcutta Urban Drainage Scheme.

They also commenced the survey of certain very high priority areas along the East—West Bengal Boundary.

In addition, a small drawing section was formed temporarily under Mr. J. S. Aswal ( Division II ) and carried out 62 square miles of 1:25,000 fair-mapping in Gangpur and Raigarh States and Sambalpur districts of Orissa—Ib River ( Rāmpur and Jamga ) Coal-fields.

Two officer surveyors, three plane-tablers and one computer from other units were trained in the air survey of planimetry and contours from vertical photographs, while several plane-tablers and draftsmen—mainly from No. 5 Party—were tested for stereoscopic fusion. In addition, two officers from the East Indian Railway were given a short course in the stereoscopic examination and interpretation of air photographs.

Numerous vertical photographs were also scrutinized in the unit to assess their





S square miles of planimetric control for 16-inch air survey.

91. **Training.**—The systematic training of Topographical Trainees, Type 'B' for Division II of the Class III Service commenced in Southern Circle with the raising of No. 17 Party as a Training Party in August 1947 and the transfer of No. 10 Party to Southern Circle from Eastern Circle as a second training Party in December 1947. The first batch of Trainees came to the Circle on transfer from the late Frontier Circle at the time of the partition of India. These Trainees were at first attached in batches to Southern Circle units and were later collected into No. 17 Party where they were organized into sections according to the stage of training reached. Systematic training was then commenced on the lines of a regular training syllabus, details of which are given in Appendix to Technical Notes, Technical Report, 1948-49.

Further recruitment of Trainees was carried out in January, May and September 1948. This was spread over the whole of the Southern Circle area; but keeping in view the formation of Western Circle, special consideration was given to obtaining an appropriate percentage of candidates from Western India to provide Class III personnel for Western Circle. The recruiting centres where candidates were assembled for selection by the Regional Employment Exchanges, were Bangalore, Vellore, Nāgpur, Sholāpur, Bombay, Poona, Hubli, Surat and Ahamadābād. Very few candidates were obtained from districts which were distant from Bangalore. This was due to reluctance to accept appointments outside their home centres.

In September 1948 when it was finally decided to move No. 17 Party from Bangalore to Belgaum, the trainees of Nos. 10 and 17 Parties were cross posted in order to bring together in No. 17 Party all the trainees recruited in Western India.

A batch of 20 trainees from Eastern Circle, with 2 Instructors, joined No. 10 Party for a full course of training in September 1948.

The maximum number of trainees in the Circle just prior to field season 1948-49 was 168.

### HEADQUARTERS SECTION

92. **General.**—The section under the charge of Mr. M. W. Kalappa ( Class II ) was employed on the air survey and mapping required in connection with development and irrigation schemes. A small batch of 16 Topographical Trainees, Type 'B', was attached to the section for a short course of training in air survey. This training was combined with productive work in the field. The section was under the direct technical control of the Director, Southern Circle.

553 square miles of 1-inch air-cum-ground survey.

79 square miles of 2-inch air survey.

289 linear miles of secondary levelling.

( b ) 1948-49.—1,050 square miles of 1-inch blue print ground survey.

1,716 square miles of 1½-inch and 2-inch air-cum-ground survey.

2¼ square miles of 32-inch air survey.

60 square miles of 4-inch air survey.

847 square miles of triangulation.

33 linear miles of traverse.

63 square miles of tertiary levelling.

99. **Field Work.**—The field work was organized as follows :—

( a ) 1947-48.—*Camp I.*—Mr. J. A. Cabral ( Class II ) with 16 to 21 Plane-tablers completed 2,245 square miles of ground survey ( blue print survey ) on the 1-inch scale in Surat, Broach, Pānch Mahāls and West Khāndesh districts of Bombay and in Baroda State.

*Air Survey Section.*—Mr. G. E. Bower ( Class II ) with one Class II Probationer, 1 Surveyor and 6 to 10 Plane-tablers completed 553 square miles of field verification and contouring on air photographs in Broach district and in Baroda State. The section also completed 79 square miles of 2-inch air survey for Līmdī, Vājpur and Dharoi Dam sites.

*Levelling.*—Messrs. K. R. Basu and D. Sen, Surveyors ( Topographical Assistants ), completed 289 linear miles of secondary levelling in connection with the Vājpur and Līmdī Dam site surveys.

*Framework.*—Mr. C. Sivaraman ( Class II Probationer ) completed a small programme of supplementary control to provide additional heights for contouring.

( b ) 1948-49.—*Camp I.*—Mr. G. E. Bower ( Class II ) with 2 Surveyors and 6 to 15 Plane-tablers ( including Topographical Trainees, Type ' B ' ) completed 1,160 square miles of air-cum-ground survey in Surat and Broach districts of Bombay and in Baroda State. The camp also completed air survey compilations of the Ukāi Dam site and Moj Commanded Area on the 32-inch and 4-inch scales respectively.

*Camp II.*—Mr. B. S. Chopra ( Surveyor ) with one Surveyor and 10 to 12 Plane-tablers ( including Topographical Trainees, Type ' B ' ) completed 1,633 square miles of blue print and air-cum-ground survey in Surat, Broach, Pānch Mahāls and West Khāndesh districts of Bombay and in Baroda State.

*Camp III.*—Mr. P. Ramamoorthy ( Class II Probationer ) with one Surveyor and 4 Plane-tablers completed 64 square miles of triangulation, 33 linear miles of traverse, a close network of tertiary levelling over an area of 63 square miles and 60 square miles of ground verification and contouring for the 4-inch air survey of the Moj Commanded Area in Saurāshtra.

commanded area of the Tungabhadra Project in the Raichūr district of Hyderābād State. During the field season of 1948-49 the party also completed planimetric control for the 16-inch air survey of the Kistna Dam site in the Kurnool district of Madras.

The political unrest in Hyderābād State in the latter part of 1948 had a slight adverse effect on the progress of survey. Not only was the opening of the field season slightly delayed, but even after political conditions had returned to normal, difficulties were experienced in obtaining local supplies of food, petrol and transport owing to the sudden change in the State administration.

The field headquarters of the party were at Raichūr.

104. **Personnel.**—The strength of the party was 1 Class I officer, 2 Class II officers, 7 to 10 Surveyors (Topographical Assistants) and 27 Topographical Trainees, Type 'B'. For field season 1948-49 this strength was reinforced by 18 more Topographical Trainees, Type 'B'.

105. **Areas Surveyed.**—

720 square miles of 4-inch original air survey of the Tungabhadra Project commanded area.

1,833 square miles of planimetric control for the 4-inch scale air survey of the Tungabhadra Project commanded area.

8 square miles of planimetric control for the 16-inch air survey of the Kistna Dam site.

1,721 square miles covered by a network of secondary and tertiary levelling and some traversing for the height control of the Tungabhadra Project commanded area.

106. **Field Work.**—The field work was organized as follows :—

(a) *Season 1947-48.—Traversing.*—A traverse detachment of 2 Surveyors (Topographical Assistants) completed 162 linear miles of theodolite traversing in Raichūr district of Hyderābād State.

*Levelling.*—Two levelling detachments consisting of three Surveyors (Topographical Assistants) and one Leveller completed 327 linear miles of secondary levelling in Raichūr district of Hyderābād State.

*Tertiary Levelling and Resection Camp.*—Mr. J. E. David (Class II) with 2 Surveyors (Topographical Assistants) and 20 Topographical Trainees, Type 'B', completed a tertiary levelling net over 761 square miles of the Tungabhadra commanded area in Raichūr district of Hyderābād State. This camp also simultaneously pin-pointed, by photo resection on air photographs of the area, all the bench-marks and pillars of the levelling net.

(b) *Season 1948-49.—Traversing.*—A traverse detachment consisting of 2 Surveyors (Topographical Assistants) completed 68 linear miles of Hunter's Short Base traversing in Raichūr district of Hyderābād State for the Tungabhadra commanded area. The

syllabus are given in Appendix to Technical Notes. Technical Report, 1948-49.

The party office opened at Bangalore in December 1947 with a strength of 39 trainees. Further recruitment of 21 trainees in May 1948 and 33 trainees in September 1948 was carried out. All recruitment was made through Regional Employment Exchanges. The Employment Exchanges were notified of the number of candidates required and the minimum qualifications a candidate should possess for appointment. Batches of candidates were then assembled by the Employment Exchanges at fixed centres where they were interviewed, tested and selected. The selection of candidates for appointment was made by Mr. J. C. Berry, the Officer in charge of the party. This procedure has resulted in obtaining a very good type of recruit with almost no necessity for weeding out after appointment.

110. **Personnel.**—The average strength of the party consisted of 1 Class I officer, 2 Class II officers, 3 Surveyors, 8 Plane-tablers as Instructors and 69 Topographical Trainees, Type 'B'.

Trainees of Nos. 10 and 17 Parties were cross posted in September 1948 and as a result of this 33 trainees were transferred to No. 17 Party and 17 trainees joined the unit from No. 17 Party.

A batch of 20 trainees with 2 Instructors were posted to the unit from Eastern Circle for a full course of training.

111. **Recess Work.**—Training during recess was carried out in and around Bangalore and consisted of theodolite traversing and computations, levelling and computations, preliminary air survey and fair drawing.

112. **Field Work.**—Training in the field was carried out in the Nandi Hills area, about 40 miles north of Bangalore, in the Kolar district of Mysore State. The first field season extended from November 1948 to April 1949. Training consisted of plane-tabling on the scale of 1,25,000. The trainees were grouped in three camps under the charge of Mr. I. K. Ponnappa (Class II) and Messrs. M. A. Azim and A. Francis (Surveyors) as Camp Officers. Each camp consisted of 23 trainees with 4 Instructors. At the conclusion of the plane-tabling course the trainees were put through a short course of interpretation of air photographs in the same area.

Mr. S. R. M. Louis (Class II Probationer) carried out triangulation of 280 square miles in the training area to provide supplementary framework for plane-tabling.

113. **Description of Country.**—The area selected for training comprised open and gently undulating country with sufficient prominence in the way of isolated rocky hillocks and spurs to provide training in the survey of hill features. The most prominent feature in the area was the Nandi Hills of which the main hill, Nandidrug, rises out of the plain to a height of 4,800 feet. The area

in the Kolar district of Mysore State. The headquarters of the party remained at Bangalore.

Field training consisted of plane-tabling on scales 1,25,000 and 1-inch to 1 mile.

The field camps were organized as follows :—

*Camp ( 1 ).*—31 trainees under Mr. I. K. Ponnappa ( Class II ), assisted by 5 Instructors.

*Camp ( 2 ).*—31 trainees under Mr. M. A. Azim ( Surveyor ), assisted by 5 Instructors.

Both camps successfully completed the plane-tabling courses on both scales, at the conclusion of which all trainees were put through a short course of interpretation of air photographs of the same area.

( b ) 1948-49.—In view of the prospective move of the party's permanent headquarters from Bangalore to Belgaum, the area for field training was selected about 30 miles south of Belgaum in parts of the Belgaum, Dhārwar and North Kanara districts of Bombay. The party headquarters remained at Bangalore and field headquarters were established at Belgaum. The field headquarters were located in the Argun Tank Lines where accommodation had been hired from the Army.

Field training was organized as follows :—

*Camp ( 1 ).*—Mr. J. A. Cabral ( Class II ) assisted by Mr. Y. D. Hegde ( Surveyor ) with 5 instructors and 26 trainees completed 1,627 square miles of 1-inch air-cum-ground survey in Belgaum, Dhārwar and North Kanara districts of Bombay. This was productive work and formed part of the field survey programme of Southern Circle for 1948-49. Air survey compilation and detail survey of this area had been carried out in recess 1948 by the same batch of trainees.

*Camp ( 2 ).*—Mr. M. N. Kutty ( Class II ) with 3 instructors and 21 trainees completed the training course of plane-tabling on scales 1,25,000 and 1-inch to 1 mile.

118. Description of Country.—For a description of the Nandi hills training area see No. 10 Party's report.

The training area south of Belgaum consisted of fairly hilly country covered by dense mixed forest in which bamboo predominated. The western part of the area extended up to the Goa boundary in the Western-Ghats and a characteristic feature of this portion of the area was the bareness of the more prominent hill tops. The whole area was well traversed by fair weather roads maintained by the Forest Department.

119. Recess Work 1948.—Training during recess 1948 was carried out in and around Bangalore.

The trainees were grouped in two sections :—

One section of 37 of the more advanced trainees, under Mr. M. N. Kutty ( Class II ), assisted by 3 instructors, took up the

## PART II.—MAP PUBLICATION AND OFFICE WORK

From 15th August 1947 to 31st March 1949

### VI. INTRODUCTION

121. *Progress of Map Publication.*—Index maps D to G, at the end of this report, show graphically the progress of publication to date of all standard series of modern maps, excluding those maps which are classified as “Restricted”, and are not available to the public.

122. *Work of Map Drawing and Printing Offices.*—The work of the drawing and printing offices of the Department for the period under report is described in three sections of Part II of this report, as follows :—

*Section VIII* ( page 62 ) gives statistics of map publications, extra-departmental printing undertaken and map issues.

*Section IX* ( page 67 ) describes the work of the drawing offices and includes two tables which quantitatively summarize this work.

*Section X* ( page 70 ) describes the work of the printing offices.

123. *Map Publication Policy.*—The period under report is of special significance as it immediately follows the partition of the country. This involved considerable transfers and changes of personnel, plant and equipment. The widespread disturbances during the early part of the period resulted in unusually heavy demands for printing maps for the army and all branches of Map Publication had to work on a war emergency basis in order to meet military requirements.

As a consequence the hopes for reversion to map publication in full pre-war colours had to be postponed, and the colour policy for the period under report remained practically the same as it was during the period of the previous report.

There were considerable demands on the Department for multi-colour lithographic printing for commercial firms and this work has become a regular feature of departmental activity. Apart from commercial work for private firms the Map Publication office has produced a large number of extra-departmental maps, booklets, brochures and posters in several colours. Owing to the difficulty of obtaining prompt publication of letterpress work, this Department has been called upon to reproduce lithographically a large number of books and pamphlets for Ministries of the Government of India.



*Asst. Manager—*

Mr. C. V. M. Hayman, from 5-1-48 to 30-4-48.

„ P. N. Kirpal, B.A., from 29-8-48 to 2-11-48.

„ P. K. Gupta, B.Sc., from 1-5-48.

*Electrical Engineer—*Mr. A. L. Sood.

*Photo-Zinco Office**Asst. Manager—*

Mr. P. N. Kirpal, B.A., to 2-11-48.

„ Bhagat Singh.

*Map Record & Issue Office*

( *Hathibarkala* )

*Chief Map Curator—( Temporary )—*

Mr. I. J. Mendes, to 29-2-48.

*Officer in charge—*

Mr. N. C. Nath, M.A., from 1-3-48.

Shillong. Director, Eastern

## Circle

Major R. T. L. Rogers, M.A., B.E., to 15-12-47.

„ R. S. Kalha, I.A., from 16-12-47 to 2-1-48.

„ I. H. R. Wilson, B.E., from 3-1-48 to 17-5-48.

Mr. B. N. Saha, M.Sc., from 18-5-48 to 9-11-48.

Major R. T. L. Rogers, M.A., B.E., from 10-11-48.

Calcutta. Deputy Director,

## Eastern Circle

Mr. B. N. Saha, M.Sc., to 1-9-47 and from 21-2-48 to 31-3-48.

Major R. S. Kalha, I.A., from 2-9-47 to 23-2-48.

Mr. C. P. E. Davenport, from 1-4-48 to 12-1-49 and from 17-2-49 to 12-3-49.

„ P. A. Thomas, from 13-1-49 to 16-2-49.

„ M. M. Ganapathy, B.A., from 13-3-49.

*No. 5 Drawing Office**Officer in charge—*

Mr. C. P. E. Davenport, to 27-9-47 and from 28-10-47 to 29-11-47.

„ L. J. Bagnall, B.Sc., from 28-9-47 to 27-10-47, from 5-1-48 to 16-2-49 and from 6-3-49.

„ N. L. Gupta, C.E., from 30-11-47 to 8-2-48 and from 1-3-48 to 4-4-48.

Mr. S. C. Chatterjee, B.Sc., from 9-2-48 to 29-2-48.

„ P. A. Thomas, from 17-2-49 to 5-3-49.

*Class II—Officer Surveyors—*

Mr. P. C. Sen Gupta, B.Sc.

„ S. C. Chatterjee, B.Sc., from 1-3-48 to 30-6-48.

„ L. J. Bagnall, B.Sc., from 17-2-49 to 5-3-49.

„ K. Sukhran Singh, B.A. ( Hons. ), from 1-11-47 to 29-2-49.

„ A. K. Sen Gupta, B.Sc., from 1-5-48 to 31-10-48.

*Class III—Surveyors—*

Mr. N. C. Nang.

„ S. K. Gulia, from 29-4-48.

„ L. R. Howard, from 28-3-48 to 30-10-48.

„ A. H. Sarkar, B.Sc., from 28-6-48 to 30-10-48.

„ A. K. Sarkar, B.Sc., from 5-7-48 to 5-11-48.

„ S. K. Dutta, B.Sc., from 5-7-48 to 30-10-48.

„ G. A. Ferns, from 5-7-48 to 22-10-48.

„ S. K. Ghose, B.Sc. ( Hons. ), from 5-7-48 to 5-11-48.

„ Kulwant Singh, B.Sc., from 9-7-48 to 6-10-48.

„ S. N. Roy, B.A. ( Hons. ), from 13-4-48 to 30-10-48.

„ G. S. Bagchi, to 14-12-47.

*Photo-Litho Office**Manager—*

Mr. K. L. Dey, to 20-8-48.

„ C. V. M. Hayman, from 1-9-48.

*Asst. Manager—*

Mr. C. V. M. Hayman, to 3-1-48.

„ G. Thomas, from 2-2-48.

*Map Record & Issue Office**Officer in charge—*

Mr. B. N. Saha, M.Sc., to 8-9-47 and from 10-11-47 to 29-2-48.

„ L. J. Bagnall, B.Sc., from 9-9-47 to 9-11-47.

„ A. K. Talapatra, B.A., from 1-3-48.

*Engraving Office**Head Engraver—*

Mr. G. J. Saha, to 7-11-47.

„ A. R. J. Dalziel, from 8-11-47.

*Asst. Head Engraver—*

Mr. G. J. Saha, from 8-11-47 to 21-9-48.



## VIII. PUBLICATIONS, EXTRA-DEPARTMENTAL PRINTING AND MAP ISSUES

124. Publications and Extra-departmental Printing.—The publications of the department during the period and printing done for other Government Departments and for the public are summarized in the following tables :

Table I ( *a* ) Departmental maps.

Table I ( *b* ) Extra-departmental maps.

Table I ( *c* ) Litho-printing, other than maps.

The progress made up to the end of the period under report in publication of the main series of topographical and geographical maps produced by the department is given in Table II. Table III shows the letterpress publications for the period.



Table III—( *concl'd.* )

12. Silviculture Research Code, Vol. II.
13. Index to Topo. Hand-Book X.
14. In addition to above, correction slips to Grid, Levelling and Survey Research Series Pamphlets, and Addenda and Corrigenda to Historical Records, Volume I, were published.

## (b) IN HAND AT DEHRA DUN

1. General Report 1946-47.
2. Technical Report 1946-47, Parts I and II.
3. Tide-Table Indian Ocean 1950.
4. Triangulation Pamphlet N H-38-F.
5. Auxiliary Tables, 6th Edition Part II ( Reprint ).
6. " " 7th Edition Part III ( Reprint ).
7. Tide-Table Bombay 1950.
8. " " Rangoon 1950.
9. " " Hooghly River 1950.
10. Topo. Hand-Book, Chapter I.
11. Historical Records, Vol. II.

## (c) PUBLISHED AT CALCUTTA

Several minor printing jobs, including that of Agmark Label Tobacco, were completed during the period under report.

## (d) IN HAND AT CALCUTTA

1. Agmark Label Tobacco.
2. Miscellaneous Departmental Forms, etc.
3. Alphabetical Index to Calcutta and Howrah Guide Map.
4. Half-tone Blocks.

## Out-turn of Letterpress Printing Sections

Section	Items of pages published	Copies printed	Impressions pulled
Dehra Dun ..	1,216	25,60,719	30,67,310
Calcutta ..	524	5,24,524	0,62,002
TOTAL ..	1,740	30,85,243	37,29,312

Table IV—Maps issued

	CENTRAL AND PROVINCIAL GOVERNMENT DEPARTMENTS			DEFENCE FORCES			PUBLIC			TOTAL			FURTHER ISSUES		
	Number of copies	Sale Value Rupees	Number of copies	Number of copies	Sale Value Rupees	Number of copies	Number of copies	Sale Value Rupees	Number of copies	Sale Value Rupees	Number of copies	Sale Value Rupees	Number of copies	Sale Value Rupees	Number of copies
<b>DEPARTMENTAL</b>															
Dehra Dūn ..	92,088	1,19,839	12,90,318	71,226	10,11,247	84,415	14,62,632	18,18,501	4,596	5,450					
Calcutta ..	13,711	50,860	7,18,520	24,904	2,69,145	31,560	7,87,165	3,51,805	36,807	39,016					
Shillong ..	918	1,039	48	1,247	54	1,162	2,243	2,545	1,534	1,712					
Bangalore ..	6,317	8,568	..	3,010	..	4,033	9,527	12,601	3,439	3,439					
Delhi ..	6,471	10,303	..	8,510	..	16,544	..	..	190	325					
Total (Departmental) ..	1,49,765	1,90,809	50,17,886	1,08,927	18,83,746	1,38,004	52,01,567	21,85,512	46,575	50,002					
<b>EXTRA-DEPARTMENTAL</b>															
Dehra Dūn ..	53,904	29,405	570	1,000	202	2,775	56,374	32,382	7,307	9,515					
Calcutta ..	13,67,851	1,44,052	24,055	46,064	9,020	30,010	14,37,970	1,92,112	11,035	12,295					
Shillong ..	8	21	..	..	..	..	8	21	..	..					
Bangalore ..	..	..	..	..	..	..	..	..	..	..					
Delhi ..	502	941	..	509	..	1,001	..	..	..	..					
Total (Extra-departmental) ..	14,92,265	1,71,425	24,625	48,473	9,222	42,816	14,94,352	2,24,518	19,002	21,810					
Grand Total ..	15,72,030	3,65,234	50,12,511	1,57,190	18,92,968	1,80,820	67,55,919	2,10,030	65,577	71,812					

Note:—(i) Total Mounting charges during the period....Rs. 63,652.  
(ii) 361,350 copies of Departmental maps and 32,249 copies of Extra-departmental maps issued on stock transfer.



(iv) 67-mile map of India showing Railways, corrected up to 30th September 1948.

127. No. 2 Drawing Office, Dehra Dun.—The main departmental work in this office during the period under report was new compilation of quarter-inch sheets and reissue of one-inch and quarter-inch sheets. Some sheets of Hind 5014 series on scale 1 : 500,000, were also prepared for the Defence Forces, India, in accordance with the specifications issued by Geographical Section, General Staff, A.H.Q., India.

Since the amalgamation of the Map Record Office of the Geodetic Branch with the Map Record and Issue Office of the Map Publication Directorate from 1st January 1949, this office took over the work of the Business Section of Northern Circle and is now responsible for the storage of all original records of departmental maps of Northern Circle and all records of Cantonment, Forest and Extra-departmental maps prepared in Northern Circle.

The Forest Map Office as such was abolished and attached to No. 2 Drawing Office as a separate section from October 1947. This section continued to meet all demands for forest maps from the contributing Provinces. In addition, paid-for work for non-contributing Provinces and States, and several Forest Maps for the Government of Burma were also completed.

128. No. 4 Drawing Office, Bangalore.—Apart from normal drawing work on departmental 1-inch and  $\frac{1}{2}$ -inch sheets, a section was entirely employed on minor projects and large scale town development maps compiled from air photographs.

The Maintenance and Record sections had to check and arrange a large number of original records received from other Directorates. The transfer of Records was due to the re-allocation of areas of regional responsibility. Maintenance work involved corrections to boundary as a result of the introduction of the integration and merger schemes.

129. No. 5 Drawing Office, Calcutta.—Besides the normal work of reissue and reprint of departmental  $\frac{1}{2}$ -inch and 1-inch maps respectively, this office also completed the following :—

- ( i ) Drawing of some sheets of Hind 5002 and 5014 series on scale 1 : 500,000 for the Defence Forces, India.
- ( ii ) Province map of Central India & Gwalior, Central Provinces & Berar, and Rajputana & Ajmer-Merwara on scale 1 : 1,000,000.
- ( iii ) Preparation of mosaics of Jamshedpur maps; Air cover Index for R.A.F. Assam, and Cinchona Research Station Kalimpong map, Plot A and B on scale 96 inches to 1 mile.

During the recess 6 Levellers and 12 Topo. trainees, Type 'B', were given preliminary training in drawing, plotting and projection, etc. 6 Surveyors were also trained in fair-mapping.



## X. WORK OF PRINTING OFFICES

132. Hathibarkala Photo-Litho Office (H.L.O.) Dehra Dūn.—  
In addition to normal departmental map publication, a large number of maps for political and defence purposes were printed during the period. Various kinds of lithographic printings, as cited below were also executed for other government departments :—

- ( i ) Pamphlets and Monthly Bulletins, Agmark Ghee and Butter labels were printed for the Ministries of Agriculture and Commerce.
- ( ii ) Maps, Drawings, Plans, etc., were reproduced for development schemes, such as Dam Projects, Road constructions and Civil Aviation.
- ( iii ) Graphs and Charts for the Industrial development were printed for the Director of Industrial Statistics.
- ( iv ) Posters, Brochures, etc., were printed for the Information & Broadcasting Ministry and the Chief of Air Staff, Air H.Q. India.
- ( v ) Postal forms, Railway diagrams, Electricity development scheme were also printed for different departments of the Government of India.
- ( vi ) A variety of work for the Development Schemes of the various States was also done.

Besides the above, a considerable amount of private jobs of educative value such as a World Atlas, Highway Code, etc., was also undertaken.

The following Printing Machines and proving Presses were in use :—

### *Lithographic Printing Machines :—*

- One Crabtree Fully Automatic Quad Demy Single Colour Offset with H.T.B. Feeder.
- One Crabtree Fully Automatic Quad Demy Double Colour Offset with H.T.B. Feeder.
- Three Crabtree Fully Automatic Double Demy Double Colour Offset with H.T.B. Feeder.
- One Crabtree Fully Automatic Double Demy Single Colour Offset with H.T.B. Feeder.
- One Mann Fast Three Fully Automatic Quad Demy Single Colour Offset with M.S. Feeder.
- One Mann Fast Five Fully Automatic Quad Demy Double Colour Offset with M.S. Feeder.
- One Mann Standard Double Demy Single Colour Offset Hand-fed.





One Crabtree Fully Automatic Double Demy Double Colour Offset with H.T.B. Feeder.  
 Two Mann Standard Double Demy Hand-fed Single Colour Offset with chain delivery.  
 Two Mann Double Demy Hand-fed Single Colour Offset with Chute delivery.  
 One Ratcliffe Quad Demy Flat-bed.  
 One Mann Double Elephant Flat-bed.

*Lithographic Proving Presses :—*

One Mann Quad Crown Offset Proving and Duplicating Press.  
 One Mann Quad Demy Offset Proving and Duplicating Press.  
 One Mann Double Demy Offset Proving and Duplicating Press.  
 Two Furnival Double Imperial Proving Presses.  
 Two Furnival Double Elephant Proving Presses.  
 One Greige Special Double Imperial Proving Press ( Hand Driven ).  
 One Hoe Double Imperial Proving Press ( Hand Driven ).  
 Two Hoe Double Elephant Proving Presses ( Hand Driven ).

*Letterpress Printing Machines :—*

One Dawson & Sons Double Demy Warfedale.  
 One Linotype & Machinery Double Crown Centurette.  
 One Rockstoreh & Schneider Foolscap Victoria Platen.  
 One Furnival Crown Folio Platen.  
 One Ruling Machine.

134. Photo-Zinco Office, Dehra Dūn.—The administrative control of this office was taken over by the Director, Map Publication from the Director, Geodetic Branch from 1st December 1947.

Apart from printing departmental maps, charts and diagrams, a fairly large number of extra-departmental maps, such as Cantonment maps, Projects maps, Forest maps including those of Burma, were printed during the period. The booklet "Forty trees common in India" and other Indian Forest Bulletin Leaflets for the Forest Research Institute and Fan Protractors for the Indian Ordnance Factory were also printed.

A total of 31 I.O.R.'s ( Indian other ranks ) were given training in different trades of map reproduction during the period under report. A new batch of 13 I.O.R.'s and one Junior Commissioned Officer have been under training since 14-2-49.

The following Printing Machines and Presses were in use :—

*Lithographic Printing Machines :—*

Two Crabtree Fully Automatic Double Demy Single Colour Offset with H.T.B. Feeder.  
 Three Crabtree Fully Automatic Double Demy Double Colour Offset with H.T.B. Feeder.  
 Two Mann Double Demy Single Colour Offset Hand-fed.

Table VIII—Out-turn and Cost of the Photo-Litho Offices

Name of Office	Maps printed (departmental and extra-departmental)	Work other than maps—Number of items	Number of Negatives prepared	Number of Zinc printing plates prepared	Number of impressions pulled	Value of out-turn at office rates	Total expenditure of the printing offices during year under report
<b>1. Dehra Dūn</b>						Rupees	Rupees
Map Publication Office							
(a) Hathi-barkala Litho Office	919	271	6,434	10,276	1,74,86,695	11,26,468	6,48,875
(b) Photo-Zinco Office	1,355	22	4,578	7,370	74,97,715	7,52,148	5,53,101
<b>2. Calcutta</b>							
Eastern Circle Photo-Litho Office	893	12	5,904	8,380	52,87,064	6,17,333	6,57,460
<b>Total</b>	<b>3,167</b>	<b>305</b>	<b>10,916</b>	<b>26,026</b>	<b>3,02,71,474</b>	<b>24,95,949</b>	<b>18,59,436</b>

Table IX—Out-turn of Process Engraving

Name of the Printing Office	Process Engraving Section			
	Half-tone Work		Line Work	
	Blocks prepared	Impressions pulled	Blocks prepared	Impressions pulled
<b>Dehra Dūn</b>				
Map Publication Office	Nil	Nil	Nil	Nil
<b>Calcutta</b>				
Eastern Circle ..	80	1,700	61	3,196

For impressions pulled see Table X.

## PART III.—GEODETIC WORK

### **XI. ABSTRACT OF GEODETIC OPERATIONS**

137. **General.**—Purely geodetic operations include miscellaneous computations and research, preparation and publication of records, observatory work (astronomical, magnetic, seismological and meteorological), measurement of geodetic bases, principal triangulation, geodetic levelling, precise latitudes, longitudes, azimuths, gravity determinations and prediction of tides at 39 ports between Suez and Singapore.

These operations were previously fully described in the annual Geodetic Reports of the Survey of India, but during the war no Geodetic Reports were published except for a short one for 1940, which placed on record only the most important items of geodetic work to safeguard against the risk of their being forgotten altogether. A complete account of all the geodetic work is now regularly published in Part III of the Technical Report. The first volume of this series is for 1947, which covers the period 1st October 1939 to 30th September 1947. The following is a brief account of the geodetic operations from 1st October 1947 to 31st March 1949. A fuller account is given in Technical Report 1948-49, Part III.

138. **Triangulation.**—The Primary and Secondary Triangulation of India which has often been loosely described as Geodetic was carried out between 1802 and 1882 when the skeleton framework of the geodetic triangulation was reckoned to be complete and the net was adjusted by simultaneous grinding for obtaining final values of co-ordinates—a process which took 20 years to complete. A number of secondary series was observed between 1909 and 1917 with a view to filling in the gaps between primary series and a vast amount of topographical triangulation was carried out to provide the framework for 1-inch maps. Very little has been done by way of primary triangulation since 1882 except a few series observed mainly in Baluchistan and Burma.

The precision of the existing topographical triangulation is generally not enough for providing a basis for surveys on scales larger than 1-inch and the geodetic framework was not at all designed for this purpose, its stations being located in remote and not easily accessible places. In the plains high tower stations were used and these have been mostly damaged or destroyed. No serious primary traverses have been run in India as a substitute for geodetic triangulation.

The strengthening and extension of the G.T. triangulation and the provision of a sufficiently dense and precise framework to provide scale and azimuth in areas where there is likelihood of large

continued. 16 pamphlets out of an estimated total of 76 have so far been published. Much progress, however, could not be made with the preparation of complete data triangulation pamphlets for India, due to lack of trained personnel.

144. Headquarters Routine.—The tidal predictions, the seismographical and the meteorological observations at Dehra Dūn have been carried out as usual. A touring tidal detachment carried out 29-day observations at 7 ports to provide data for improving the accuracy of tidal prediction.

para 177 ) and its main occupation during the period under report has been the training of computers, the supply of triangulation, traverse and levelling data; maintenance of progress charts of various field detachments, reprinting of auxiliary tables and professional forms, and the preparation of a second edition of certain levelling pamphlets. Some progress has also been made with the printing of triangulation pamphlets for Iran, but no progress could be made with the systematic adjustment of topographical triangulation all over India and its publication in pamphlets due to shortage of suitably trained personnel.

147. **Gravity Anomalies.**—The Mineral Adviser to the Government of India (now Director, Bureau of Mines) in consultation with the Geological Survey of India has suggested three priority areas which are considered to be economically productive:

The first area covers Raniganj coal-fields (about 70 miles in length and 40 miles in breadth), the second covers an area of about 20,000 sq. miles round Nagpur and the third, an area of about 340 miles in length and 90 miles in breadth near Belgáum. It is proposed to cover these areas by a 10-mile network of Gravimetric stations. The observations in the Raniganj area comprising of 30 stations have been completed. Observations have also been made at 76 stations in the Nagpur area where further work will be continued during the coming field season. Reduction of these observations and the calculations of the gravity anomalies according to the various hypothesis is a laborious job and is being carried out in the Computing Office.

148. **Levelling.**—The following lines of high precision levelling were carried out during the period under report :—

- ( i ) Ratnāgiri to Bombay in the back direction.
- ( ii ) Kolhāpur to Ratnāgiri in the back direction.
- ( iii ) Kolhāpur to Katwar in the fore direction.
- ( iv ) Raipur to Vizagapatam in the fore direction.
- ( v ) Burdwan to Diamond Harbour in both, back and fore directions.
- ( vi ) Diamond Harbour to Dublat in both, back and fore directions.
- ( vii ) Howrah to Jaleswar in fore direction.

Lines ( i ) to ( iv ) were carried out as part of the departmental programme for the new level net of high precision levelling and lines ( v ) to ( vii ) above were carried at the request of the River Surveyor to the Port of Calcutta for providing height datum for his Tide-Gauge stations.

Besides the above, secondary levelling from Hoshangābād to Mhow was carried out for height datums required by the Executive Engineer, Lower Narbada Division, for the Narbada and Tapi projects. The levelling was carried out both in the fore and back directions by sections of 8 miles, each section being subdivided in

stations for azimuth control of the triangulation series to which they belong.

Two detachments were formed during field season, one to determine the meridional deflection along longitude  $83^{\circ} 45'$  between Waltair and Dehri-on-Sone at 23 stations (including the two old latitude stations), and the other to determine both components of the deviation of the vertical and also to observe reciprocal azimuths at three pair of stations in Madhya Bhārat for obtaining reliable values of Prime Vertical deflections and corrections to triangulated azimuths.

The results are being computed in the Observatory Section.

### TIDAL SECTION

152. Tide-Tables.—The annual "Tide-Tables of the Indian Ocean" and the three separate pamphlets for Bombay, the Hooghly River and the Rangoon River for the year 1949 were prepared and published between July and September 1948. Advance predictions for the year 1949 and 1950 for a number of ports were sent in December 1947 and December 1948 respectively, to the Hydrographic Departments in England and the United States and to the Royal Indian Navy, as usual. At the request of Royal Indian Navy special tidal predictions for Rozi (in the gulf of Kutch) for the year 1948 were prepared and supplied, both in tables and chart form, on payment.

153. Tidal Observations.—Registrations with automatic gauges were continued by the port authorities at Aden, Karāchi, Bombay (Apollo-Bandar), Vizagapatam and Calcutta (Kidderpore). The Kent's Pneumatic gauge at Dublat (Saugor) which had to be shut down in September 1943 due to erosion of the foreshore had been re-installed by the Calcutta Port Commissioners in March 1944, and has since been working continuously. Three more self registering gauges of the Kent's Pneumatic type have been established by the Calcutta Port Commissioners during the recent years along the Hooghly, one at Gangra (established in April 1940 but destroyed by cyclone in October 1942 and re-installed in December 1942), another at Balari (established in August 1940) and the third at Diamond Harbour (established in January 1947). All these have been in operation during the period under report. Day-light observations of high and low waters on tide-poles were also continued at Bhāvnagar and Chittagong.

A programme of 29 days' systematic observations was carried out by a touring tidal detachment, newly formed in the Department, at a number of ports along the west coast of India during the field seasons 1947-48 and 1948-49.

---





## GLOSSARY

**Scales** are referred to as follows :—

- ( i ) *for scales which are multiples of 1/1,000,000—“1/M scale”, “1/6 M scale”, &c., which mean “1,000,000 scale”, “1/6,000,000 scale”, &c.,*
- ( ii ) *for scales smaller than 4 miles to one inch—“50-mile scale”, “8-mile scale”, &c., which mean “scale of 50 miles to one inch”, “scale of 8 miles to one inch”, &c.,*
- ( iii ) *for scales of and larger than 4 miles to one inch—“1-inch scale”, “ $\frac{1}{2}$ -inch scale”, “ $\frac{1}{4}$ -inch scale”, “16-inch scale”, &c., which mean “scale of  $\frac{1}{4}$ -inch to one mile”, &c., &c.,*
- ( iv ) *other scales, by their representative fraction, e.g., “1/25,000”.*

### Serial Numbering of Survey of India maps

Sheets NE-43, NF-44, &c., are sheets on 1/M scale; ( International Numbering ).  
Sheets 65, 78, &c., are sheets on the 1/M scale; ( now superseded by above ).  
Sheets 65 K, 78 F, &c. are  $\frac{1}{4}$ -inch sheets;  
Sheets 65 K/N.W., 78 F/S.E., &c., are  $\frac{1}{2}$ -inch sheets;  
Sheets 65 K/1, 78 F/16, &c., are 1-inch sheets.

The system of numbering is fully explained in the Indexes at the end of this report.

**Abbreviations**—U.S.S. denotes Upper Subordinate Service.

G.C.S. denotes General Central Service.

U.S. Officer denotes Upper Subordinate Officer.

L.S. Officer denotes Lower Subordinate Officer.

H.L.O. denotes Hathibarkala Litho Office ( Dehra Dūn ).

P.L.O. denotes Photo-Litho Office ( Calcutta ).

P.Z.O. denotes Photo-Zinco Office ( Dehra Dūn ).

D.O. denotes Drawing Office.

M.R.I.O. denotes Map Record and Issue Office.

A.I.D. denotes All-India Development.

I.C.A.O. denotes International Civil Air Organization.

## PART III. GEODETIC WORK

	Page
XI. ABSTRACT OF GEODETIC OPERATIONS ..	76
XII. SURVEY REPORTS, SURVEY RESEARCH INSTITUTE (GEODETIC BRANCH FROM 1-11-48 )	
Summary .. .. .	79
Computing and Tidal Party .. .. .	79
Computing Office .. .. .	79
Observatory Section .. .. .	81
Tidal Section .. .. .	82

## ILLUSTRATIONS

Group photograph taken after Senior Officers' Conference in Delhi—February 1948 .. .. .	Frontispiece
A 'C' type Officers' Residence on the Survey of India Estate, Dehra Dūn .. .. .	9
Survey Vehicle being ferried across the Mahanada River..	40
An aerial view of the Damodar River .. .. .	46
The entrance to the Map Publication Offices, Dehra Dūn..	58
Printing Presses at the Map Publication Offices, Dehra Dūn	62
A view of the Machine Room of the Photo-Litho Office, Dehra Dūn .. .. .	70

## INDEX MAPS

A. Modern Topographical surveys and compilation ..	At end
B. Modern Topographical surveys and revision by 10-year periods from 1905 .. .. .	At end
C. Index showing Project surveys in hand .. .. .	At end
D. Maps published on scales of 1-inch and $\frac{1}{2}$ -inch to one mile .. .. .	At end
E. Maps published on scales of $\frac{1}{4}$ -inch to one mile .. .. .	At end
F. Carte Internationale du Monde, 1/M scale .. .. .	At end
G. Southern Asia Series, 1/2M scale .. .. .	At end

The Magnetic survey :

Observation of the direction and force of gravity :

Astronomical observations to determine latitude, longitude and time ;

Seismographic and meteorological observations at Dehra Dūn.

Indian geodesy has disclosed widespread anomalies in the gravitational attraction in the earth's crust which have recently led to a reconsideration of the whole theory of isostasy. Systematic gravity investigations, which may be said to have been initiated in India by the Survey of India, are now being carried out intensively in all civilized countries.

**Topographical Surveys.**—In the past this department used to carry out the large scale revenue surveys for most of India, and was still conducting this work for Central and Eastern India and Burma in 1905.

Though revenue survey is primarily a record of individual property boundaries and is unconcerned with the surface features, ground levels and exact geographical position essential to a topographical survey, it was on the whole found economical to carry out both surveys together.

By 1905, however, the small scale topographical surveys compiled from the large scale revenue maps had fallen seriously in arrears, owing to the relatively slower pace and incompleteness of the latter, on which non-revenue-paying areas are normally shown blank.

An authoritative Survey Committee appointed by the Government of India considered the position in 1905. It was feared that a separation of the topographical and revenue surveys might result in a wasteful duplication of work and two overlapping but mutually discrepant systems of mapping. These objections were met by a ruling that the basis of both systems of survey should be identical and provided either by the Survey of India or under its supervision.

Subject to this principle, the remaining revenue surveys were handed over to the provinces, which had always paid for them as part of the overhead charges of revenue collection, and the Survey of India was enabled to concentrate its energies on a complete new series of modern topographical maps in several colours on the 1-inch to 1-mile scale.

This new series had been rendered necessary by the natural demand for more detailed information to be shown on maps, especially as regards the portrayal of hill features by contours and proper classification of communications.

It was intended that the survey begun in 1905 should be completed in twenty-five years, and then revised periodically every thirty years. Owing, however, to the 1914-19 war and more recent retrenchments, only about three fourths of the programme had been

**Air Survey.**—The use of air photographs for survey purposes has become a normal practice and air survey is employed wherever it is considered advantageous to do so. The Survey of India has arranged with a company in India for the supply, on contract rates, of such photographs as it may require for survey purposes.

Air photographs in pairs for stereoscopic examination or made up in the form of mosaics are very often of value in inspecting sites prior to undertaking detailed survey operations, or may sometimes render these unnecessary. Any demands for air photographs or mosaics should be forwarded to the office of the Surveyor General in Mussoorie or to one of the Circle Directors who will give quotations.

It may be noted that under the orders of the Government of India all demands for air photography from departments of the Central Government must be placed through the Survey of India.

**Military requirements.**—Prior to the 1939-45 war, the Survey of India was responsible for all survey operations required by the Army. During the war, a Military Survey Service was formed and this Service is likely to be retained by the Army in peacetime as a permanent measure. This arrangement will relieve the Survey of India of a considerable amount of responsibility for work for the Army, but as the Military Survey Service is likely always to be small, the Survey of India will still be called upon to do a large amount of map production for military purposes.

**Civil Aviation.**—With the establishment of an International Civil Aviation Organization, charts on varying scales to a uniform specification have been planned to cover the whole world. The production responsibility for these charts has, generally speaking, been allotted to the country whose territories cover the part of the globe concerned. In the case of India our commitments are :—

- ( i ) Charts on the 1 : 1,000,000 scale—23 in number.
- ( ii ) Instrument Approach Charts on the scale 1 : 250,000, and Landing Charts on the scale of 1 : 50,000 of all the important Civil Aerodromes in the country. These are printed back-to-back, and are about seventy-two in number.
- ( iii ) Besides the above, charts on the 1 : 500,000 and 1 : 250,000 scales, Route Charts and various Plotting and Planning Charts are planned, but the limits of responsibility and the final implications of these have not yet been settled.

The production of these various series of I.C.A.O. Charts is a new responsibility of this department.

**Administration.**—The administration of the Survey of India was in the hands of the Surveyor General of India under the Ministry of Agriculture. The headquarters office of the Surveyor General of India was in the Old Secretariat at Delhi and was under the administration of the Deputy Surveyor General. A technical office was



The Technical Report, arranged in three parts, on the lines of the General Report, contains figures for areas, out-turns and cost rates of surveys (including air surveys), details of surveys, and technical methods. This technical report is intended for departmental use as well as for distribution to other survey and scientific departments.

Part III of the Technical Report which deals with the geodetic and geophysical activities of the department in detail, is published as a separate volume.

There is also a supplement to the Technical Report for departmental use. This Supplement, as its name implies, is merely to supply details which are of little general interest, but which are required departmentally to record the output of individuals. It will not be printed.

The General Report and Technical Reports only deal with maps and surveys of areas where the maps are unrestricted. Particulars of surveys and maps which are "Restricted" for security purposes are given in a confidential supplement to the General Report which is a restricted document. The first issue of this since the war covering the period from 15th August 1947 to 31st March 1949 is under publication.

The progress of modern (i.e., since 1905) topographical surveys made by the department and of compilations made from our own or other material is illustrated in *Index A* at the end of this report, while *Index B* indicates the obsolescence of modern surveys. *Index C* shows project surveys in hand and the remaining *Indexes D, E, F* and *G* show all the standard maps which have been published up-to-date on various scales. It will be seen from *Index D* that the areas within India which are blank on *Index A* are actually almost entirely covered by topographical maps. These maps are, however, prepared from material based on the old longitude of 1815, which was over 2 miles in error, are mostly uncontroled, are drawn in the old style and are many years out of date; they are consequently excluded from *Index A*.

It may be mentioned here that besides the standard maps shown in *Indexes D, E, F* and *G*, this department also publishes aeronautical maps on the 1/M scale of an area covering India and adjacent countries, Landing and Approach Charts on scales of 1/50,000 and 1/250,000 respectively for all civil aerodromes in India. Province maps on 1/M scale, Town Guide maps varying from 3 inches to 16 inches to one mile, maps of India on scales of 40, 70, 128 and 192 miles to an inch, special maps like Railway maps of India, Road maps of India, as well as Town maps and Cantonment maps from special surveys.

2. Surveyor General's Office.—BRIGADIER G. F. HEANEY, C.B.E., held the post of the Surveyor General of India throughout the period under report except for a period of four months on leave from 26th May to 28th September 1948, when MAJOR (L/BRIGADIER) I. H. R. WILSON, officiated in his place.

( b ) *British Military Officers*.—The British Treasury agreed to the payment of lump sum compensation to British Military Officers in the Survey of India, who decided to leave India either on retirement or reversion to British Service as the result of the constitutional changes. The majority of the British Military Officers of the Survey of India, proceeded on leave either preparatory to retirement or pending reversion to the Home establishment, within a few months of the introduction of the constitutional changes.

( c ) *Revised Pay Rules*.—The Central Civil Services ( Revision of Pay ) Rules 1947 for personnel of the Survey of India were published in the Gazette of India dated the 20th December 1947.

The main feature of these rules is the large increase in pay granted to Class IV personnel ( *khalāsis*, etc. ). This has with subsequent amendments greatly added to the cost of field work.

( d ) *Reorganization of Military Survey Services*.—The Government of India has approved of the Surveyor General of India being in technical charge of the Military Survey Service, as Director of Military Survey, in addition to his other duties, provided he is a military officer.

The post of the Director, Military Circle, was abolished from 30th February 1948 and in lieu a purely military post of Deputy Director of Survey, carrying the rank of full Colonel, was sanctioned.

The post of Assistant Director, Military Circle had been abolished with effect from the 15th August 1947.

( e ) *Changes in Names and Designations*.—The Government of India approved of the following changes in designations of appointments in the Survey of India :—

( i ) *New Names for Circles*.—The following changes in the names of the Geodetic Branch and the Survey Research Institute were introduced with effect from the 1st November 1948 :—

----- Geodetic Branch—changed to Northern Circle.

Survey Research Institute—changed to Geodetic Branch.

( ii ) *Designations of Class I and II Officers, Sub-Assistant Superintendents, Topographical Assistants* :—

Old Designation	New Designation
<i>Class I Service</i>	
Superintendent.	Superintending Surveyor.
Assistant Superintendent.	Deputy Superintending Surveyor.
<i>Class II Service</i>	
Extra-Assistant Superintendent.	Officer Surveyor.
<i>Class III Service</i>	
Sub-Assistant Superintendent and Topographical Assistant.	Surveyor.
Air Surveyor.	Air Survey Draftsman.
Surveyor.	Plane-tableer.

## Designation of posts

Number on 31-3-49

Permanent Temporary

## I. FIXED ESTABLISHMENT—(concl'd.)

## (c) Class III Service—(concl'd.)

## (ii) Ministerial:

Office Superintendents ..	3	1
Head Assistants ..	2	..
Assistants in Charge ..	..	3
Assistants ..	10	14
Stenographers ..	1	1
Clerks, 2nd Division ..	13	11
Clerks, 3rd Division ..	8	25

## II. UNFIXED ESTABLISHMENTS—Class III

## (i) Technical:

Surveyors (Topographical Assistants and Temporary Computers) ..	..	96
Technical Supervisor ..	1	..
Head Mechanic, Map Mounting Estt. ..	1	..
Plane-tableing and drawing personnel including Recordkeepers ..	282	624
Reproduction personnel ..	121	315
Head Artificer and Asstt. Head Artificer ..	2	..
Other Artificers ..	..	13
Bookbinder ..	1	..
Motor Drivers ..	1	55
Compounders ..	1	2
Head Packers and Asstt. Head Packers ..	..	2

## (ii) Ministerial:

Office Superintendents ..	6*	1
Head Clerks and Head Accountants ..	12*	1
Clerks, Storekeepers and Telephone Operators ..	89	220

(g) *Revival of the Post of Registrar.*—The post of Registrar in the Surveyor General's Office which was in abeyance since November 1940 was revived from 1st May 1948 and Mr. P. N. BANERJI, M.A., B.L., was appointed to it in an officiating capacity.

## 5. Raising, Transfer and Disbandment of Units.—

*No. 17 Party.*—A new party designated No. 17 Party was formed with effect from the 15th August 1947 for the training of Class III Division II personnel and was placed under the administrative control of the Director, Southern Circle, with its headquarters at Bangalore.

*No. 14 Party.*—No. 14 Party was transferred from the administrative control of the Director, Geodetic Branch (now Northern Circle) to that of the Director, Map Publication, with effect from the 15th August 1947. It was again transferred to the administrative control of the Director, Geodetic Branch, with effect from the 1st January 1948.

\* 1 post in abeyance.



7. **Deputations.**—MR. A. K. SEN GUPTA, Officiating Superintending Surveyor, Survey of India, on deputation by the Government of India, attended as a delegate to the International Civil Aviation Organization Conference ( Map Division ) held at Brussels ( Belgium ) from the 8th March 1948.

MESSRS. J. E. DAVID, Officer Surveyor and L. R. HOWARD, Surveyor, on deputation by the Government of India proceeded to Karachi ( Pakistan ) by air on the 30th July 1948 to collect India's share of map stocks, originals and other essential stores.

MR. B. L. GULATEE, M.A. ( CANTAB. ), President, Survey Research Institute, on deputation by the Government of India attended as a delegate, the Conference of the International Union of Geodesy and Geophysics held at Oslo ( Norway ) from the 19th August 1948.

MESSRS. G. B. DAS and V. KRISHNAMURTHY, Officer Surveyors, proceeded to U.K. in October 1948 to undergo a one-year course of advanced training in air survey and photogrammetry at University College, London.

8. **Conferences and Meetings.**—A Conference was held at the West Bengal Secretariat, Calcutta, on the 4th April 1948 in which unanimous decision was reached about the survey methods to be employed for fixing the East-West Bengal boundary. The conference was presided over by the Chief Secretary, Government of West Bengal, and attended by other officials of the Government of West Bengal including the Hon'ble Member, Board of Revenue and the Director of Land Records, as well as the Surveyor General of India, the Director, Eastern Circle and MR. N. L. GUPTA, a survey officer on special duty.

Between 16th and 21st May 1948, MAJOR R. C. A. EDGE, M.B.E., R.E., Deputy Director General, Survey of Pakistan, on deputation from the Government of Pakistan, discussed with the Surveyor General of India, the question of the joint survey of East-West Bengal boundary by India and Pakistan. Joint proposals by the Surveyor General of India and the Director General, Survey of Pakistan were later submitted to the Government of India by the Surveyor General.

9. **Distinguished Visitors.**—MR. K. W. P. MARAR, I.C.S., Joint Secretary to the Government of India, Ministry of Agriculture, visited the Survey of India offices at Dehra Dūn on the 22nd December 1947, and inspected the offices accompanied by the Surveyor General.

MR. B. R. SEN, I.C.S., Secretary to the Government of India, Ministry of Agriculture, visited the Survey of India offices at Calcutta, on the 1st January 1948 and was shown the work of the different branches of the department.

MR. K. W. P. MARAR, I.C.S., Joint Secretary to the Government of India, Ministry of Agriculture, visited the Survey of India offices at Bangalore on the 2nd February 1948.



who was engaged on plane-tableing work in the mountains of Nepāl, involving climbing up to 18,800 feet on the Lunak glacier.

The Supreme Allied Commander, S.E.A.C., issued a Good Service Card to EX-SUBEDAR C. S. ANANTHAN NAIK.

**11. Miscellaneous.—(a) Communal Disturbances.**—Serious communal disturbances broke out in Delhi and Dehra Dūn during the second week of September 1947. Fortunately there were no casualties among the Survey of India personnel.

**(b) Loss from Cyclone.**—A cyclone struck the field headquarters of No. 9 Party at Forbesganj (Bihār) on the 10th May 1948 and resulted in the loss of Government stores worth about Rs. 4,000.

**(c) Technical Papers.**—The Surveyor General decided to introduce a new series of papers which will be known as technical papers, and may cover either technical or administrative subjects. These papers which will be published under the names of their writers will, it is hoped, stimulate thought and encourage original research on departmental matters and will give wide publicity to them in the Department. They will normally be fairly short and will have the same status as professional and departmental papers. Publication of which will be continued as required.

The following papers were published in this series :—

*Technical Paper No. 1.*

"Towards a National Survey".

*Author.*—BRIGADIER G. F. HEANEY, C.B.E.

*Date of Publication.*—April 1948.

*Technical Paper No. 2.*

"Value of Gravity at Dehra Dūn".

*Author.*—MR. B. L. GULATIE, M.A. (CANTAB).

*Date of Publication.*—October 1948.

**12. Personnel.**—Retirements, casualties, promotions, appointments and other changes were as follows :—

*Retirements.*—

*Class I Officers.*—BRIGADIER E. A. GLENNIE, C.I.E., D.S.O., COLONEL O. SLATER, C.I.E., M.C., COLONEL G. W. GEMMELL, LT.-COLONEL G. BOMFORD, O.B.E., R.E., LT.-COLONEL D. R. CRONE, C.I.E., O.B.E., R.E.

*Class I (General Central Service) Officer.*—MR. D. C. VERMA.

*Class II (General Central Service) Officers.*—MR. G. J. SAHA, Assistant Head Engraver, MR. G. A. H. THOMAS, Assistant Manager.

*Class III Service.*—MR. V. D. CHOPRA, Surveyor, and other 38 employees.

*On leave preparatory to Retirement.*—

*Class I Officers.*—COLONEL G. H. OSMASTON, M.C., COLONEL J. B. P. ANGWIN, M.B.E., LT.-COLONEL H. W. WRIGHT, O.B.E., R.E., LT.-COLONEL C. A. K. WILSON, O.B.E., R.E., MAJOR R. H. SAMS, R.E., MAJOR C. A. BIDDLE, R.E.

*Confirmation in Appointments.—*

*Class I Officers.*—MAJOR J. S. PAINTAL, R.I.E., MESSRS. J. C. BERRY, T. M. C. ALEXANDER, B. N. MURTHY, M. D. NANGIA, M. R. NAIR, C. T. HURLEY, P. A. THOMAS, F. M. HAWLEY, K. L. DHAWAN, M. M. GANAPATHY, K. C. GOSAIN, E. R. WILSON, J. C. ROSS—confirmed as Superintending Surveyors.

MESSRS. P. S. SHINGHAL, N. L. GUPTA, H. H. PHILLIPS, L. J. BAGNALL, N. D. JOSHI, S. C. CHATTERJEE, A. K. SEN GUPTA—confirmed as Deputy Superintending Surveyors.

*Appointments.—*

*Class I Officers.*—T/LT.-COL. P. D. JOSHI, T/MAJOR D. N. SHARMA, T/MAJOR C. M. SAHNI, T/MAJOR R. C. TYAGI appointed as Deputy Superintending Surveyors ( on probation ).

MR. N. C. NATH—appointed as Superintending Surveyor.

*Class I ( G.C.S. ) Officers.—*

MR. L. H. MORDUE—appointed as Chief Manager, Map Reproduction.

MR. O. P. GROVER—appointed as Mathematical Adviser ( on probation ).

MR. N. T. WADHWANI—appointed as Stores Officer ( Temporary ).

MR. C. G. GEHANI—appointed as Deputy Stores Officer ( Temporary ).

*Class II Officers.*—MESSRS. R. B. LALL, M. N. KUTTY, MAHINDER SINGH, A. C. CHAWLA, G. N. DUBEY, I. C. DEV, J. C. SEN GUPTA, B. K. SATPATHY, S. P. BANERJEE, S. R. MARIA LOUIS, K. VENKATARAMAN, P. RAMAMOORTHY, H. K. CHOPRA, T. C. JYOTI, B. S. RATTAN—appointed against permanent vacancies as Officer Surveyors.

MESSRS. A. C. DEX, I. R. VISWANATHAN, C. M. SAPRU—appointed as probationers in the Class II Service.

*Class II ( G.C.S. ) Officers.*—MESSRS. C. V. HAYMAN, P. N. KIRPAL—appointed as Managers, Map Reproduction.

MESSRS. BHAGAT SINGH, P. K. GUPTA—appointed as Assistant Managers, Map Reproduction.

MR. N. S. MUKHERJI—appointed as Officer Supervisor ( Temporary ).

MR. H. L. TEJWANI—appointed as Assistant Stores Officer ( Temporary ).

MR. P. DASGUPTA—appointed as Assistant Head Engraver.

*Termination of Re-employment.—*

*Class I Officers.*—MESSRS. J. L. SAHGAL, N. N. CHUCKERBUTTY, D. C. PURI, A. F. MURPHY, D. N. BANERJI.

*Class I ( G.C.S. ) Officer.*—MR. I. J. MENDES.

*Class II Officer.*—MR. R. N. HASTIR.

*Class II ( G.C.S. ) Officers.*—MR. J. B. LAL, MR. R. B. MATHUR.

## PART I.—TOPOGRAPHICAL AND OTHER SURVEYS

### II. ABSTRACT OF SURVEYS AND TOPOGRAPHICAL WORK

14. The following two tables indicate the progress achieved in the topographical survey programme assigned to the Department in 1905 and give details of the work done during the period under report.

*Table A* shows the area of survey completed on various scales since 1905, as well as the approximate balance which remains to complete the contoured topographical survey of India.

*Table B* shows the area revised during the period under report.

There is also a *Table C*, showing in detail the survey operations carried out during the period under report, together with their cost rates. This *Table C* is now published in the Technical Report.

It may be mentioned here that it was decided in 1905 that a completely new contoured survey should be undertaken of India on a scale of 1-inch to a mile and that the survey was to be completed in 25 years and thereafter completely revised at 25-yearly intervals. For various reasons the original programme was only about three quarters completed on the outbreak of war in 1939, and practically no topographical survey operations were carried out during the war and the pre-partition period. After the partition of India work on the original programme of surveys has been resumed and the two *Tables A* and *B* below show the progress made at the end of the period under report :—

**Table A.—Progress of Topographical Surveys in India  
since 1905**

Survey Years	1 inch and larger scales	$\frac{1}{2}$ and $\frac{1}{4}$ inch scales	$\frac{3}{4}$ and $\frac{1}{2}$ inch scales	TOTALS
	Sq. Miles	Sq. Miles	Sq. Miles	Sq. Miles
1905-45 ..	7,60,480	2,02,496	58,544	10,21,520
1945-47 ..	1,427	..	..	1,427
1947-49 ..	7,346	..	..	7,346
Totals to 1949 ..	7,69,253	2,02,496	58,544	10,30,293
Balance (Approximately) ..	*1,25,000	*23,000	*96,000	2,57,100
Total programme ..	..	..	..	†12,87,393

\* Subject to alterations on final decision on the scale of surveys to be undertaken.

† Revised figures after partition of India.

*Topographical surveys by ground methods* in Hazāribāgh district ( p. 34 ).

*Cantonment, etc., surveys for the Defence Services* of Rāingarh Cantonment and Ranchi Military Camp ( Kojatoli ) ( p. 29 ).

*City surveys* in Singhbhum district for town planning purposes ( p. 37 ).

*Levelling*.—Secondary, double and single tertiary levelling in Bhāgalpur, Darbhanga, Purnea and Santāl Parganas districts ( p. 40 ); levelling for surveys of Rāingarh Cantonment and Ranchi Military Camp ( p. 29 ).

*Topographical framework*.—Triangulation, traverse and supplementary height control in Bhāgalpur, Darbhanga, Gaya, Hazāribāgh, Monghyr, Muzaflarpur, Patna, Purnea and Santāl Parganas districts ( pp. 35, 39, 40, 43 ).

#### 18. Bombay.

*Topographical surveys by air methods* of Dharoi, Limdi, Ukāi and Vājpur Dams in Baroda and Navsāri States ( pp. 49-50 ).

*Topographical surveys by ground methods* in Belgaum, Broach, Dhārwar, North Kanara, West Khāndesh, Pāñch Mahāls and Surat districts and Baroda State ( pp. 50, 56 ).

*Cantonment, etc., surveys for the Defence Services*.—Surveys of proposed site for National War Academy Airfield at Aundh, Pawai Camp near Bombay, Lohegaon Airfield and Dehu Road Extension near Poona and A.O.P. Flight at Deolāli ( p. 29 ).

*Contoured photo mosaic* of Kāli Nadi Reservoir in North Kanara district ( p. 49 ).

*Levelling* of secondary precision in connection with Limdi Dam and Vājpur Dam surveys ( p. 50 ); high precision levelling of the lines Ratnagiri to Bombay, Kolhāpur to Ratnagiri and Kolhāpur to Karwar ( p. 80 ).

*Topographical framework*.—Triangulation for Ukāi Dam and Ukāi Reservoir ( p. 51 ).

*Training*.—Training of topographical trainees, Type B, for Division II of the Class III Service in Belgaum district ( p. 56 ).

#### 19. Delhi.

*Topographical surveys by air methods* in suburbs of Delhi ( p. 24 ).

*Topographical surveys by ground methods*.—Correction survey of Delhi and surrounding country ( p. 23 ).

*Cantonment, etc., surveys for the Defence Services*.—Surveys of P.O.L. Store at Delhi Cantonment, Red Fort, Shakur Basti Ordnance Depot ' Delhi ' and Delhi Cantonment lines ( pp. 28-29 ).

*Levelling* in suburbs of Delhi ( p. 22 ); for surveys of P.O.L. Store, Delhi Cantonment ( p. 28 ).

*Topographical framework*.—Traversing for surveys of P.O.L. Store, Delhi Cantonment ( p. 28 ).

*Topographical framework.*—Triangulation, traversing and supplementary height control in Morang, Okhaldunga, Rāmechhiāp, Saptari, Sindhūli Garhi and Udaipur Garhi districts (pp. 39-41).

*Geophysical work.*—Astronomical observations at one station (p. 77).

#### 25. Orissa.

*Topographical survey by air method* in Sambalpur district and Sonapur State (p. 42).

*Levelling.*—Tertiary levelling in Bolāngir and Sambalpur districts (p. 43).

*Topographical framework.*—Triangulation, traverse and supplementary height control in Angul district, and in Athmallik, Baudh, Barāmba, Daspalla, Dhenkānāl, Jharsuguda, Keonjhar, Nandīpur, Rairākhōl, Rānpur, Sonapur and Sundergarh districts.

#### 26. Patialā and East Punjab States Union.

*Topographical surveys by air methods* in Patialā, Kalsia and Nalāgarh States (p. 23).

*Topographical framework.*—Triangulation and traversing in Patialā, Kalsia and Nalāgarh States (p. 23).

*Rectangulation* in Patialā State (p. 25).

#### 27. Punjab.

*Topographical survey by air methods* in Ambāla district (p. 23).

*Cantonment, etc., surveys for the Defence Services.*—Survey of Sadar Bāzār Extension in Ambāla district (p. 29).

*Topographical framework.*—Traversing in Ambāla district (p. 26); Triangulation in Ambāla and Ludhiāna districts (p. 26).

*Rectangulation* in Ambāla, Karnāl, Hissār and Ludhiāna districts (p. 25).

#### 28. Rājasthān.

*Topographical framework.*—Traversing to fix co-ordinates of communication stations at Jodhpur and Udaipur aerodromes (p. 22).

*Geophysical work.*—Measurement of the deviation of the vertical at 2 stations in Mārwar; astronomical observations at 2 stations (p. 77).

#### 29. Saurāshtra.

*Topographical surveys by air methods* of Moj Reservoir and Commanded Area in Madhya Saurāshtra division (p. 49).

*Levelling* for Moj Commanded Area survey above (p. 51).

*Topographical framework.*—Triangulation and traverse for the Moj Reservoir and Commanded Area in Madhya Saurāshtra division (p. 51).

#### 30. Travancore-Cochin.

*Topographical survey by air methods* of Poringalkuthu Reservoir in Cochin State (p. 49).

### III. SURVEY REPORTS, GEODETIC BRANCH (NORTHERN CIRCLE FROM 1-11-1948)

DIRECTOR :— { Major R. H. Sams, R.E., to 20-8-47 and again from  
2-10-47 to 21-2-48.  
Col. G. W. Gemmell, I.A., from 30-8-47 to 1-10-47.  
Major Gambhir Singh, I.A., from 22-2-48 to 30-9-48.  
Mr. K. L. Dhawan (current duties), from 1-10-48 to  
21-11-48.  
Mr. B. N. Saha, V.Sc., from 22-11-48.

DEPUTY DIRECTOR :—Major J. S. Paintal, R.I.E., from 8-3-48 to 30-9-48.

34. Summary.—The designation of the Geodetic Branch was changed to "Northern Circle" with effect from 1st November 1948 and with effect from the same date the "Survey Research Institute" was known as the "Geodetic Branch". The units administered by the Geodetic Branch (Northern Circle from 1-11-48) were No. 1 Party, No. 13 Party, No. 14 Party (from 1-1-48), No. 15 Party, No. 20 (Cantt.) Party, No. 2 Drawing Office, Map Record Office (up to 20-2-48), Stores Office, Surveys, Survey Training Centre (from 1-9-47 to 31-5-48), the Printing Office (up to 31-10-48) and the Photo-Zinc Office (up to 30-11-47).

#### 35. Areas Surveyed.—

- 26 square miles of 4-inch original ground survey.
- 447 square miles of 4-inch original air survey.
- 11 square miles of 10-inch original air survey.
- 9 square miles of 16-inch original air survey.
- 50.3 square miles of 16-inch original air survey (outline only).
- 2.1 square miles of 32-inch original air survey.
- 26.4 square miles of 100 feet to 1-inch original air-cum-ground survey.
- 995 square miles of 1-inch correction survey.
- 96.5 square miles of triangulation for air survey control.
- 374 linear miles of traversing for air survey control.
- 175 linear miles of tertiary levelling.
- 290.5 square miles of height control.
- 3,413 square miles of rectangulation to 100 acre in Ambāla, Hissār, Karnāl and Ludhiāna districts & Patiāla and East Punjab States Union.
- 3,531 square miles of tertiary levelling in Ambāla, Hissār and Ludhiāna districts & Patiāla and East Punjab States Union.
- 3,043 square miles of rectangulation to 3,000 acre in Ambāla, Karnāl and Ludhiāna districts & Patiāla and East Punjab States Union.



39. **Field Work.**—The field work was organized as under :—

( i ) *Delhi Development Survey.*—Mr. R. S. Chugh ( Class II ) with 9 plane-tablers completed 10·3 square miles of ground verification and contouring, vertical interval 5 feet, on the scales of 40 inches to 1 mile in an area south of Delhi and tertiary levelling of 81 linear miles for height control in an area north of Delhi.

Mr. Suresh Prasad ( Class II ) with 9 plane-tablers completed 15·4 square miles in an area north of Delhi and 0·7 square miles in an area south of Delhi of ground verification and contouring ( vertical interval 5 feet ) on the scale of 40 inches to 1 mile.

These surveys were enlarged to produce maps on a scale of 100 feet to 1 inch.

The area was undulating. The flat portions were mostly built-up or covered with fruit gardens and the remainder covered with rocky outcrops. This area is being rapidly developed.

( ii ) *Fixation of Co-ordinates of Communication Facilities in Aerodromes.*—Co-ordinates of communication facilities were fixed for Palam and Willingdon aerodromes in Delhi, and for aerodromes at Jodhpur and Udaipur.

( iii ) *Rāmanga Dam Site Survey.*—Survey of 11 square miles on 10-inch scale was carried out in Garhwāl district.

Mr. Suresh Prasad ( Class II ) with plane-tablet Bakhtawar Singh completed the planimetric and height control for air survey.

( iv ) *Patiāla State Development Survey.*—Survey of 9·5 square miles on 16-inch scale was carried out in Patiāla state.

Mr. K. B. K. Menon ( Surveyor ) provided planimetric and height control for air survey of Chail, Kandaghāt and Barog colonies.

( v ) *Rewa and Satna Town Surveys.*—Survey of 6·5 and 2·5 square miles respectively on 16-inch scale was carried out of these towns.

Mr. K. B. K. Menon ( Surveyor ) carried out 63 linear miles of traversing for control for air survey besides providing control for the preparation of a 16-inch rectified air photo-mosaic of Rewa town.

Messrs. H. K. Chopra and T. C. Jyoti ( both Class II probationers ) with Mr. Jai Kirti Singh ( Division II ) completed the ground verification and contouring ( vertical interval 10 feet ). They also carried out linear miles of tertiary levelling for the purpose of providing a network of spot heights approximately 400 feet apart.

( vi ) *Survey for proposed Agra Central Railway Station ( G.I.P. ).*—Survey of 2·1 square miles on 32-inch scale was carried out in Agra district.

Mr. Suresh Prasad ( Class II ) provided control for air survey and rectification of air photographs by traversing 19 linear miles.

towards the end of February 1949 and very little was done during the period under report.

(xii) *Karnāli River Survey in Silgarhi-Doti, Dailekh, Kailāli and Salyāna districts of Nepāl.*—This work was required in connection with the Ghāgra Power Scheme of the U.P. Government. Preliminary reconnaissance only was started.

There were three sections at the party headquarters at Dehra Dūn throughout the field season; two drawing and air survey sections under Messrs. Govind Prasad (Surveyor) and Jai Prakash (Division I) and one computing section under Mr. A. P. Gupta (Computer).

40. *Recess Duties.*—The party was organized for the recess into 4 drawing and air survey sections under Messrs. R. S. Chugh, Ratna Singh, Govind Prasad and Arjan Dev as section officers assisted by Messrs. Sohan Singh, and Jai Prakash as assistant section officers and completed the following jobs :—

(i) *Konār Project.*—2 sheets of Konār Dam Survey on 16-inch scale, covering an area of 4.7 square miles; 2 sheets of Konār Pipe Line and 1 sheet of Konār Reservoir on 6-inch scale, covering an area of 33 square miles were completed in Hazāribāgh district. Planimetric and height control was provided by the Eastern Circle.

(ii) *Ashni River Project.*—Appliqué slip for sheet No. 3 on 4-inch scale, covering an area of 4 square miles was completed in Patiāla.

(iii) *Agra Central Railway Station Survey.*—Air survey of outline only of 3 sheets on 32-inch scale was completed.

(iv) *Rewa and Satna Town Survey.*—Outline only of 1 sheet of Satna and 2 sheets of Rewa town on 16-inch scale were completed.

(v) *Delhi Development Survey.*—Air survey of outline only of 52 sheets of the northern area and 2 sheets of the southern area (Lodi Colony) was completed on 40 feet to 1-inch scale. Drawing of 32 sheets of the southern area with 5 feet contours was completed for final printing.

(vi) *Rāmgaṅga Dam Site Survey.*—2 sheets on 10-inch scale were completed for final printing.

(vii) *Karnāli River Survey in 1949.*—Air survey of outline only of 375 square miles on 2-inch scale was completed in Nepāl.

(vii) *East Punjab Capital Site Survey.*—11 sheets on 4-inch scale were completed.

(viii) *Cattle Breeding Research Station, Jubbulpore.*—1 sheet on 4-inch scale was completed.

(ix) *Kānpur (Cawnpore) Development Survey.*—23 sheets on 16-inch scale covering an area of 50.3 square miles, were fairdrawn.

(x) *Computations.*—All computations of triangulation, traversing and levelling, carried out during the field season 1947-48, were again independently computed during recess 1948.

completed 570 square miles of tertiary levelling to 25 acres in Hissār district.

*Camp ( Levelling ).*—Mr. A. N. Malhotra ( Class III Division I ) with 17 other Class III personnel completed 694 square miles of tertiary levelling to 25 acres in Hissār district and Patiāla State.

*Triangulation.*—Mr. Dayanand ( Class III Division I ) completed 300 square miles of triangulation in Ambāla and Ludhiāna districts and Patiāla State.

*Verification Survey.*—Messrs. Dayanand and Mohan Ram ( Class III Division I ) carried out verification surveys of major detail in seven 1-inch sheets in Hissār district.

( b ) 1948-49.

*Camp ( 1 ).*—Mr. A. C. Chowla ( Class II ) with 2 Class III Division I and 15 other Class III personnel completed 724 square miles of rectangulation to 100 acres in Karnāl and Ludhiāna districts and Patiāla and East Punjab States Union.

*Camp ( 2 ).*—Mr. Amar Singh ( Class III Division I ) with 3 Class III Division I and 6 other Class III personnel completed 3,043 square miles of combined theodolite traversing and rectangulation to 3,000 acres in Ambāla, Karnāl and Ludhiāna districts and Patiāla and East Punjab States Union. The traverse computations were completed *pari passu*, by a small sub-section of this camp consisting of 5 Class III computers ( later decreased to 3 ).

*Camp ( 3 ).*—Mr. Dayanand ( Class III Division I ) with 11 other Class III personnel completed 413 square miles of rectangulation to 100 acres in Ambāla district and Patiāla and East Punjab States Union.

*Camp ( 4 ).*—Mr. A. N. Malhotra ( Class III Division I ) with one Class III Division I and 11 other Class III personnel completed 85 square miles of rectangulation to 100 acres and 1,049 square miles of tertiary levelling to 25 acres in Ambāla and Ludhiāna districts and Patiāla and East Punjab States Union. Levelling computations were carried out *pari passu*, by a small sub-section of this camp consisting of 2 Class III computers ( later increased to 3 ).

*Camp ( 5 ).*—Mr. Dial Singh ( Class III Division I ) with 14 other Class III personnel completed 713 square miles of rectangulation to 100 acres and 1,218 square miles of tertiary levelling to 25 acres in Hissār district and Patiāla and East Punjab States Union. Levelling computations were carried out *pari passu*, by a small sub-section of this camp consisting of 2 Class III computers. To enable this camp to complete its allotted area which was of the highest priority, it was reinforced in strength towards the end of the field season, by 6 class III rectangulators from Camp ( 3 ), 2 class III levellers from Camp ( 4 ) and one Class III computer from Camp ( 2 ).

Computers). During 1948-49 the strength was 1 Class II probationer, 5 Burmese Officers, 6 Class III personnel ( Temporary Computers ) and 13 Topographical Trainees, Type 'B'.

Four R.I.E. officers, on posting to the Survey of India, joined the unit during February 1949 for training.

### No. 20 ( CANTONMENT ) PARTY

*Officer in charge* :— { Mr. K. L. Dhawan, to 16-11-47.  
Mr. C. T. Hurley, from 17-11-47 to 31-10-48.  
Mr. M. D. Nangia, from 1-11-48.

50. General.—The party surveyed cantonments, and other military lands in all the Army Commands at different scales, in accordance with the programme approved by the Engineer-in-Chief and the Ministry of Defence.

The 1947-48 field season commenced on the 10th of November 1947 and closed on 24th of May 1948. The 1948-49 field season commenced on the 24th of September 1948 and closed on the 31st of May 1949, except for a few jobs that will be continued till the end of June 1949. The headquarters of the party remained at Dehra Dūn for both the field seasons 1947-48 and 1948-49.

51. Personnel.—The average strength of the party, including the Officer in charge, was one Class I officer, one Class II officer, one Upper Subordinate officer ( now Surveyor ), 3 Topographical Assistants ( now Surveyors ), 1 re-employed Upper Subordinate officer and 1 Division I, 16 plane-tablers, 6 draftsmen, 6 traversers, 4 computers, 5 clerks, 1 record-keeper, 6 topographical trainees and 1 store-keeper.

### 52. Areas Surveyed.—

4-inch survey	6,400 acres.
8-inch survey	4,385 „
16-inch survey	33,904 „
24-inch survey	230 „
64-inch survey	729 „

53. Field Work.—( a ) The field work for 1947-48 was organized as follows :—

*Camp ( 1 ).*—With headquarters at Ambāla Cantonment under Mr. Bakhshi Harnam Singh ( re-employed Upper Subordinate officer ), with 12 plane-tablers and 2 traversers, completed the detail survey of Ambāla Cantonment, Meerut Cantonment and P.O.L. Store Delhi Cantonment.

Traversing and levelling for the P.O.L. Store and traversing of a portion of Remount Depot, Bābugarh were also completed.

Three Topographical Assistants ( now Surveyors ) and one Computer ( Trig. ) were attached to the camp in March 1948 for training in large scale plane-tabling.

54. **Traversing and Levelling.**—221·9 linear miles of traversing and 109·6 linear miles of levelling were carried out during 1947-48 to provide control for various jobs completed.

826·1 linear miles of traversing and 434·1 linear miles of levelling were carried out during 1948-49 to provide control for the various jobs completed during the field season and for the future survey of Ferozepore Cantonment.

55. **Recess Duties.**—( *a* ) *Season 1947-48.*—The fair mapping was carried out by 2 sections during the recess under Messrs. Bakhshi Harnam Singh ( re-employed Upper Subordinate officer ) and P. K. Chowdhury ( Surveyor ).

Also 2 air survey training sections under Messrs. A. N. Gosain ( Class II ) and Ratna Singh ( Surveyor ), were responsible for the training of 6 officers and 10 air survey draftsmen.

Mr. O. C. Dobhal ( Computer ) was in charge of the computing section throughout at Dehra Dūn.

( *b* ) *Season 1948-49.*—Fair mapping during the recess of 1948 was carried out by 3 sections under Messrs. A. N. Gosain ( Class II ), Bakhshi Harnam Singh ( re-employed Upper Subordinate officer ) and P. K. Chowdhury ( Surveyor ).

Mr. O. C. Dobhal ( Computer ) was in charge of the computing section throughout the year at Dehra Dūn.

### STORES OFFICE, SURVEYS

*Stores Officer* :— { Mr. F. M. Hawley, to 31-10-48.  
                           { Mr. T. M. C. Alexander, from 1-11-48 to 26-1-49.  
                           { Mr. N. T. Wadhvani, G.C.S. Class I, from 27-1-49.

56. **General.**—The Stores Office organized in 1941 with a view to centralize all survey and reproduction stores, viz., instruments, equipment, books and forms, technical stationery as well as furniture needed by the units of the Survey of India and Military Survey Units, which were being raised for operational purposes, continued to do useful work throughout the period under report.

A system of control over certain items of reproduction stores and photographic materials was instituted to prevent the limited stocks of such stores being completely depleted. This control was operated in consultation with the Director, Map Publication.

Units, disbanding after the war, returned large quantities of stores and a 100% physical check of the quantities in hand was started to arrive at the exact position. The major part of this work was completed.

The partition of stores between the two Dominions of India and Pākistān was also implemented during the period under report and some stores were handed over to Pākistān. The handing over of the remaining continued.

#### IV. SURVEY REPORTS, EASTERN CIRCLE

DIRECTOR:—	Major R. T. L. Rogers, R.E., to 15-12-47.
	Major R. S. Kalha, I.A., from 16-12-47 to 2-1-48 (in addition to his duties as Deputy Director).
	Major I. H. R. Wilson, R.E., from 3-1-48 to 17-5-48.
	Mr. B. N. Saha, M.Sc., from 18-5-48 to 9-11-48 (in addition to his duties as Deputy Director up to 4-7-48).
	Major R. T. L. Rogers, R.E., from 10-11-48.
DEPUTY DIRECTOR:—	Mr. B. N. Saha, M.Sc., to 1-9-47 and from 21-2-48 to 4-7-48.
	Major R. S. Kalha, I.A., from 2-9-47 to 23-2-48 (in addition to his duties as Director from 16-12-47 to 2-1-48).
	Mr. C. P. E. Davenport, from 5-7-48 to 23-12-48 and from 17-2-49 to 12-3-49.
	Mr. L. J. Bagnall, from 24-12-48 to 12-1-49.
	Mr. P. A. Thomas, from 13-1-49 to 16-2-49.
	Mr. M. M. Ganapathy, B.A., from 13-3-49.

60. Summary.—The units administered by Eastern Circle were Nos. 5, 9, 11, 12 Parties. No. 10 Party (up to 9-12-47 when it was transferred to Southern Circle), Map Record and Issue Office, (up to 29-2-48 when the charge was transferred to Dehra Dun), Photo-Litho Office, No. 5 Drawing Office, and the Engraving Office. The latter three units are located in Calcutta and their annual reports will be found in Sections IX and X of this volume.

No normal topographical survey programme was carried out. All parties were employed on extra-departmental surveys for development projects such as :—

Hydro-electric, irrigation, geological investigation, town planning, river control, land reclamation, alignment of electric power lines, railway construction and barrage construction; surveys in connection with disputed portions of the East-West Bengal boundary; and Tea Garden surveys for one of the large Agency firms.

##### 61. Areas Surveyed.—

- 1200 square miles of triangulation.
- 1683 linear miles of traverse.
- 2633 square miles of supplementary height control.
- 1093 linear miles of tertiary simultaneous double levelling.
- 14007 linear miles of tertiary single levelling.
- 546 linear miles of secondary levelling.
- 146 square miles of 4-inch revision ground survey.
- 187 square miles of 4-inch verification (contour) survey.
- 8 square miles of 16-inch revision ground survey.
- 66 square miles of 1-inch original air survey.
- 12 square miles of 4-inch original air survey.
- 300 square miles of control for 4-inch air survey.
- 31 linear miles of 1·5-inch revision air survey.

65. **Personnel.**—The average field strength of the party was as follows :—

1947-48.

1 Class I officer, 6 Class II officers ( including 5 probationers ), 49 Class III personnel ( including 5 Surveyors 2 Division I ) and 6 clerks and record-keepers.

1948-49.

1 Class I officer, 2 Class II officers ( including one probationer ), 50 Class III personnel ( including 11 Surveyors and 2 Division I ) and 8 clerks and record-keepers. One Class II probationer and one Class III ( Surveyor ) joined late in March.

In addition to the above strength 10 Class III personnel ( including 2 Surveyors and 1 Division I Draftsman ) remained at party headquarters for computations, air survey and fair drawing.

66. **Areas Surveyed.**—

1947-48.

732 square miles of triangulation.  
309 linear miles of theodolite traverse.  
829 square miles of supplementary height control.  
198 linear miles of tertiary simultaneous double levelling.  
499 linear miles of tertiary single levelling.  
124 square miles of 4-inch revision ground survey.  
187 square miles of 4-inch verification ( contour ) survey.  
4.5 square miles of 16-inch revision ground survey.

1948-49.

120 square miles of triangulation.  
759 linear miles of theodolite traverse.  
365 linear miles of tertiary simultaneous double levelling.  
1,277 linear miles of tertiary single levelling.  
119 square miles of 4-inch revision air survey.  
3.1 square miles of 16-inch revision ground survey.  
1,317 square miles of verification of detail on photographs.

67. **Field Work.**—Field work was organized as follows :—

1947-48.

( a ) *Jamshedpur Town Extension.*—Mr. S. Das Gupta ( Division I Field Staff ) with 5 plane-tablers completed 4.5 square miles of 16-inch revision ground survey in Singhbhum district.

( b ) *Kopili River Flood Control Project.*—Messrs. J. C. Sen Gupta ( Class II probationer ), J. K. Chatterjee, D. P. Chatterjee and K. L. Chakraborti ( Surveyors ), 15 levellers and 7 plane-tablers assisted by

and 6-inch Konār Pipe Line Extension  
Survey in Hazāribāgh district.

1948-49.

( a ) *Calcutta Electrification Scheme ( Route Survey of Transmission Line )*.—Mr. A. K. Sen Gupta ( Class II ) with one leveller completed 99 linear miles of theodolite traverse and 78 linear miles of tertiary levelling in Nadia and 24 Parganas districts for fixation of points at 150 and 300 yards' intervals as pointed out in the field by the liaison officer from the department of Electricity Development, West Bengal.

( b ) *Digha Town Planning*.—Mr. K. S. Loverwell ( Division I Field Staff ) with one leveller carried out 36 linear miles of theodolite traverse, 51 linear miles of tertiary levelling and 3.1 square miles of revision survey on 16-inch scale ( with 5-foot contours ) in Midnapore district. Two plane-tables assisted him in the later part of the field season—one from mid-March and the other from mid-April.

( c ) *Dihāng Reservoir Survey*.—Orders for this survey were received late in the field season. Messrs. D. Sen, S. Ray and H. S. Iyer ( Surveyors ) were sent but could only complete 50 linear miles of theodolite traverse for planimetric and height control for 4-inch air survey due to unusually early and incessant rains from March onwards.

Messrs. A. H. Sarkar and S. K. Datta ( Surveyors ) assisted by 2 levellers carried out 120 linear miles of tertiary simultaneous double levelling for establishing bench-marks in the area.

( d ) *Ganga Bridge Project*.—Mr. K. L. Chakraborti ( Surveyor ) from 5th December, Mr. J. K. Chatterjee ( Surveyor ) from 7th February, Mr. A. K. Sen Gupta ( Class II ) from 16th March and Mr. S. P. Banerjee ( Class II probationer ) from 24th March, completed 296 linear miles of theodolite traverse and 120 square miles of triangulation for fixation of  $\frac{1}{2}$ -mile and 1-mile bank points and 3-mile Khadir points and 808 square miles of verification of detail on photographs. Computations of all traverse work were done in the field by one computer.

( e ) *Kopili River Flood Control Project*.—Survey of this project was divided into three camps as follows :—

*Camp ( 1 )*.—Mr. J. C. Sen Gupta ( Class II probationer ) with Messrs. D. Sen, N. K. Pal Choudhury, S. Ray, A. H. Sarkar,



## No. 9 PARTY

*Officer in charge.*—Mr. H. H. Phillips.

70. **General.**—All the surveys carried out by the party were extra-departmental jobs for the Central Waterpower, Irrigation and Navigation Commission.

The party carried out the following survey operations during the field season 1947-48 :—

Irrigation surveys, on scale 4-inch to a mile, in connection with the Kosi Project, in the Bhāgalpur and Purnea districts of Bihār and the Udaipur Garhi, Saptari and Morang districts of Nepāl.

Triangulation and large scale ground survey of the Kosi dam site in the Udaipur Garhi and Morang districts of Nepāl.

Triangulation in the Kosi Catchment area in the Udaipur Garhi, Rāmechhāp, Okhaldhunga and Sindhūli Garhi districts of Nepāl.

In addition to the above main operations, theodolite traverse and secondary levelling were done in the Darbhanga, Bhāgalpur and Purnea districts of Bihār and the Morang and Saptari districts of Nepāl ; and ground survey on scale  $\frac{1}{2}$ -inch to a mile of the 250-foot and 300-foot contours was done in the Purnea district of Bihār and the Morang district of Nepāl.

The party carried out the following survey operations in the year 1948-49 :—

Irrigation surveys on scale 4-inch to a mile in connection with the Kosi Project, in the Purnea district of Bihār and the Morang district of Nepāl.

Surveys on scale 4-inch to a mile in connection with the Ganga Barrage Scheme, in the Santāl Parganas district of Bihār and the Mālda and Murshidābād districts of West Bengal.

Survey and marking on the ground of the 1100-foot contour along the gorge of the Kosi River and its tributaries, in the Udaipur Garhi, Bhojpur, Okhaldhunga and Dhankuta districts of Nepāl.

The field headquarters of the party during both the field seasons was at Forbesganj in the Purnea district of Bihār, and its recess headquarters was at Mussoorie in the Dehra Dūn district of Uttar Pradesh.

71. **Personnel.**—The strength of the party, during the field season 1947-48, was 1 Class I officer, 2 Class II officers ( including 1 probationer ), 7 Surveyors, 1 Division II and 68 Class III personnel including 6 clerks.

The strength of the party during the field season 1948-49, was 1 Class I officer, 4 Class II officers ( including 1 Class II probationer ), 11 Surveyors, and 77 Class III personnel including 7 clerks.

72. **Area Surveyed.**—

In the field season 1947-48 :—

390 square miles of triangulation for 1-inch air survey.

0.2 square mile of triangulation for 1/1000 ground survey.

*Nepāl Triangulation.*—Messrs. Mahinder Singh ( Class II probationer ) and R. L. Sharma ( Surveyor ) completed 390 square miles of triangulation in the Udaipur Garhi, Okhaldhunga, Rāmechhāp and Sindhūli Garhi districts of Nepāl, to provide planimetric control for 1-inch air survey of a portion of the Kosi catchment area.

*Planimetric and Height Control Framework.*—Mr. S. N. Barthwal ( Surveyor ) assisted by Mr. R. L. Sharma ( Surveyor ) for the first half of the season, carried out 85·0 miles of traverse in the Darbhanga district of Bihār and the Saptari district of Nepāl, to provide the planimetric control for the air survey compilation of irrigation sheets, for the next season's Kosi Irrigation survey programme, but this work was not utilized due to alterations in the programme initiated by the indentor.

A secondary levelling detachment under Mr. K. L. Puri ( Surveyor ) carried out 194·1 miles of secondary levelling in the Darbhanga and Purnea districts of Bihār and the Morang and Saptari districts of Nepāl, to provide a framework of height control for next season's Kosi Irrigation survey programme. As in the case of traverse, a major portion of this secondary levelling was not utilized.

Field work in 1948-49 was organized as follows :—

*Camp ( 1 ).*—Mr. Mahinder Singh ( Class II ) assisted by Mr. S. N. Barthwal ( Surveyor ) with 5 plane-tablers, 15 levellers and 4 computers ( including 3 computers ) completed ground verification for air survey and "stone-laying" of  $11\frac{1}{2}$  sheets covering an area of 310·5 square miles, 98·1 miles of double tertiary levelling, 2484 miles of tertiary levelling, and computations of both the types of levelling.

*Camp ( 2 ).*—Mr. R. D. Verma ( Surveyor ) with 3 plane-tablers, 10 levellers and 3 computers completed ground verification for air survey and "stone-laying" of 9 sheets covering an area of 243 square miles, 81·7 miles of double tertiary levelling, 1944 miles of tertiary levelling and computations of both the types of levelling.

The areas of work of both the above camps fell in the Purnea district of Bihār and the Morang district of Nepāl.

*Camp ( 3 ).*—Mr. G. N. Dubey ( Class II ) with Messrs. S. K. Ghosh, N. M. Das, V. R. C. Shahane, K. R. Basu, G. A. Ferns ( all Surveyors ), 5 plane-tablers, 9 levellers and 3 computers completed 178 square miles of triangulation with its computations, 140·7 miles of traverse, 199·4 miles of double tertiary levelling, and 1650 miles of tertiary levelling with their computations, and 476·6 square miles of ground verification for air survey, in the Santāl Parganas district of Bihār and the Mālda and Murshidābād districts of West Bengal. The field work of the camp will provide material for air survey compilation and 4-inch mapping, with contouring at one-foot vortical interval, of a portion of the area of the Ganga Barrage Scheme.

2 Surveyors of the same camp carried out 60 miles of traverse on both banks of the Ganges river from a point 5 miles above



*Training.*—Mr. Mahinder Singh ( Class II ) and Messrs. S. N. Barthwal, K. L. Puri, R. L. Sharma and Avinash Chandra ( all Surveyors ) were temporarily posted to No. 15 Party ( N.C. ), during the recess, for training in air survey.

7 Computers were trained in the early part of the field season 1947-48 and 3 levellers and a record-keeper were attached to the drawing sections of the party in recess for training in draftsman-ship.

### No. 10 PARTY

*Officer in charge:*—Mr. S. C. Chatterjee, to 9-12-48.

76. *General.*—The party was employed on 4-inch surveys in connection with the Tista Irrigation Project. Further field work on this project was suspended after the partition of India as the majority of the area fell in Pakistan. During the period under report the fair mapping of eleven 4-inch sheets was completed.

The charge of the party was transferred to Southern Circle with effect from 10th December 1948, the personnel having been absorbed into No. 11 Party.

77. *Personnel.*—The average strength of the party was 1 Class I, 4 Class II, and 66 Class III officers including clerks.

### No. 11 PARTY

*Officer in charge:*— $\left\{ \begin{array}{l} \text{Mr. M. M. Ganapthy, B.A., to 23-8-47.} \\ \text{Mr. N. L. Gupta, from 24-8-47 to 29-11-47.} \\ \text{Mr. C. P. E. Davenport, from 30-11-47 to 1-7-48.} \\ \text{Mr. S. C. Chatterjee, from 2-7-48.} \end{array} \right.$

78. *General.*—The party completed 4-inch irrigation survey of 90 sheets of which 54 sheets have been fair-mapped. The party also completed ground survey of Hirākud Dam area on scale 1/1,000 fair-mapping of which would be taken up in the recess of 1949; height control for a portion of Bihār Mica Belt area and planimetric control for a portion of Tikkarpāra reservoir area including a portion for which height control had also been completed. The recess headquarters of the party was at Mussoorie in the year 1947 and later transferred to Rānchi in 1948 but the field headquarters of the party remained at Sambalpur during the period under report. On the 1st of December 1947 the party was strengthened by the addition of personnel of No. 10 Party, the charge of which unit was transferred to Southern Circle. This party had been employed on surveys for the Tista Irrigation Project which was suspended after the partition of India.

79. *Personnel.*—The average strength of the party during the period under report was 1 Class I, 5 Class II ( two under training ), 10 Surveyors, 17 Plane-tablers, 53 Levellers, 11 Computers, 7 Clerks and 2 Store-keepers.

80. *Area Surveyed.*—

140 square miles of triangulation.

1459 square miles of 4-inch revision air survey of detail only.

*Camp (5).*—Mr. S. N. Sanyal (Surveyor), 2 Surveyors, 6 Levellers and 2 Computers completed control for 4-inch air surveys of 300 square miles in the Tikkarpāra Reservoir area.

*Camp (6).*—Mr. M. R. Subramaniam (Surveyor), 8 Planetablers, 2 Levellers and 1 Computer completed ground survey of 2.65 square miles of Hirākud Dam area on scale 1:1,000.

82. *Miscellaneous.*—The health of the party was generally very satisfactory. At the beginning of each season most of the men were vaccinated. Paludrine was liberally used as a preventive to malaria. Three Class IV personnel died of various diseases and one Class III officer was struck by lightning while working in the field. He was killed instantly.

83. *Recess Duties.*—For recess 1948, the fair-mapping and computation of levelling of 43, 4-inch sheets was divided into three sections, in charge of Messrs. M. K. Chatterjee (Class II), K. Sukhrām Singh (Class II), and S. R. M. Louis (Class II).

#### NO. 12 PARTY

*Officer in charge:*—Mr. J. C. Ross.

84. *General.*—The party carried out large and small scale air surveys, together with triangulation, supplementary height control, plane-tableing, ground verification, compilation and fair-mapping for various flood control, hydro-electric, geological investigation, land reclamation, town planning, boundary delineation and railway construction projects in Assam, West Bengal, Bihār, Nepāl, Orissa and the Uttar Pradesh.

85. *Personnel.*—The average strength of the unit was 1 Class I, 3 Class II and 22 Class III officers including 4 clerks.

#### 86. Areas Surveyed.—

- 0.5 square miles of triangulation.
- 180 square miles of supplementary height control.
- 66 square miles of 1-inch original air survey.
- 31 linear miles of 1.5-inch revision air survey.
- 12 square miles of 4-inch original air survey.
- 2 square miles of 4-inch revision air survey.
- 7 square miles of 4-inch revision ground survey.
- 69 square miles of 6-inch revision air survey.
- 53 square miles of 16-inch revision air survey.
- 0.5 square miles of 16-inch revision ground survey.
- 0.6 square miles of 32-inch original air survey.

#### 87. Field Work.—

Season 1947-48—Nil.

Season 1948-49—Mr. S. Rai (Class II Probationer) carried out the following:—

0.5 square miles of triangulation in Hazāribāgh district of Bihār for the Bokāro Dam Extension survey.

7.4 square miles of 4-inch revision survey of planimetry and contours, by plane-table, in Hazāribāgh district—Bokāro Coal-field.

11.7 square miles of 4-inch original air survey of detail, contours and form-lines, in Bhojpur, Dhankuta, Morang and Udaipur Garhi districts of Nepāl-Barāhakshetra. This figure excludes compilation by this section of 2.6, 1.1 and 0.6 square miles from the Kosi Reservoir ( 4-inch ), Kosi Dam ( 32-inch ) and Kosi Dam Extension ( 32-inch ) surveys, respectively.

0.8 square mile of 6-inch revision air survey of contours only, in Hazāribāgh district, appliqué slips to Konār Pipe Line and Pipe Line Extensions surveys.

10.7 square miles of 16-inch revision air survey of detail and contours, in Hazāribāgh district—Berma-Bhāndaridah Gorge.

0.8 square mile of fair-mapping in the Darjeeling district of West Bengal—Gielkhola ( Tista High ) Dam.

Entering selected detail and heights on a 3-inch photographic mosaic of the Um Tru Reservoir.—See first item below.

The two above-mentioned sections jointly carried out the following :—

29.9 square miles of 16-inch revision air survey of detail and contours, in Hazāribāgh district of Bihār and Khāsi and Jaintiā Hills district of Assam—Konār Pipe Line Extensions and Um Tru Reservoir.

4.7 square miles of 16-inch revision air survey of contours only, in Hazāribāgh district—Konār Dam.

These sections also commenced the undermentioned surveys which had to be suspended at various stages to give place to others of higher priority :—

Bokāro Coal-field.

Deolbāri Dam.

Calcutta Urban Drainage Scheme.

They also commenced the survey of certain very high priority areas along the East—West Bengal Boundary.

In addition, a small drawing section was formed temporarily under Mr. J. S. Aswal ( Division II ) and carried out 62 square miles of 1:25,000 fair-mapping in Gangpur and Raigarh States and Sambalpur districts of Orissa—Ib River ( Rāmpur and Jamga ) Coal-fields.

Two officer surveyors, three plane-tablers and one computer from other units were trained in the air survey of planimetry and contours from vertical photographs, while several plane-tablers and draftsmen—mainly from No. 5 Party—were tested for stereoscopic fusion. In addition, two officers from the East Indian Railway were given a short course in the stereoscopic examination and interpretation of air photographs.

Numerous vertical photographs were also scrutinized in the unit to assess their



8 square miles of planimetric control for 16-inch air survey.

91. **Training.**—The systematic training of Topographical Trainees, Type 'B' for Division II of the Class III Service commenced in Southern Circle with the raising of No. 17 Party as a Training Party in August 1947 and the transfer of No. 10 Party to Southern Circle from Eastern Circle as a second training Party in December 1947. The first batch of Trainees came to the Circle on transfer from the late Frontier Circle at the time of the partition of India. These Trainees were at first attached in batches to Southern Circle units and were later collected into No. 17 Party where they were organized into sections according to the stage of training reached. Systematic training was then commenced on the lines of a regular training syllabus, details of which are given in Appendix to Technical Notes, Technical Report, 1948-49.

Further recruitment of Trainees was carried out in January, May and September 1948. This was spread over the whole of the Southern Circle area; but keeping in view the formation of Western Circle, special consideration was given to obtaining an appropriate percentage of candidates from Western India to provide Class III personnel for Western Circle. The recruiting centres where candidates were assembled for selection by the Regional Employment Exchanges, were Bangalore, Vellore, Nāgpur, Sholāpur, Bombay, Poona, Hubli, Surat and Ahamadābād. Very few candidates were obtained from districts which were distant from Bangalore. This was due to reluctance to accept appointments outside their home centres.

In September 1948 when it was finally decided to move No. 17 Party from Bangalore to Belgaum, the trainees of Nos. 10 and 17 Parties were cross posted in order to bring together in No. 17 Party all the trainees recruited in Western India.

A batch of 20 trainees from Eastern Circle, with 2 Instructors, joined No. 10 Party for a full course of training in September 1948.

The maximum number of trainees in the Circle just prior to field season 1948-49 was 168.

### HEADQUARTERS SECTION

92. **General.**—The section under the charge of Mr. M. W. Kalappa ( Class II ) was employed on the air survey and mapping required in connection with development and irrigation schemes. A small batch of 16 Topographical Trainees, Type 'B', was attached to the section for a short course of training in air survey. This training was combined with productive work in the field. The section was under the direct technical control of the Director, Southern Circle.



553 square miles of 1-inch air-cum-ground survey.

79 square miles of 2-inch air survey.

289 linear miles of secondary levelling.

( b ) 1948-49.—1,050 square miles of 1-inch blue print ground survey.

1,716 square miles of 1½-inch and 2-inch air-cum-ground survey.

2¼ square miles of 32-inch air survey.

60 square miles of 4-inch air survey.

847 square miles of triangulation.

33 linear miles of traverse.

63 square miles of tertiary levelling.

99. **Field Work.**—The field work was organized as follows :—

( a ) 1947-48.—*Camp I.*—Mr. J. A. Cabral ( Class II ) with 16 to 21 Plane-tablers completed 2,245 square miles of ground survey ( blue print survey ) on the 1-inch scale in Surat, Broach, Pānch Mahāls and West Khāndesh districts of Bombay and in Baroda State.

*Air Survey Section.*—Mr. G. E. Bower ( Class II ) with one Class II Probationer, 1 Surveyor and 6 to 10 Plane-tablers completed 553 square miles of field verification and contouring on air photographs in Broach district and in Baroda State. The section also completed 79 square miles of 2-inch air survey for Līndi, Vājpur and Dharoi Dam sites.

*Levelling.*—Messrs. K. R. Basu and D. Sen, Surveyors ( Topographical Assistants ), completed 289 linear miles of secondary levelling in connection with the Vājpur and Līndi Dam site surveys.

*Framework.*—Mr. C. Sivaraman ( Class II Probationer ) completed a small programme of supplementary control to provide additional heights for contouring.

( b ) 1948-49.—*Camp I.*—Mr. G. E. Bower ( Class II ) with 2 Surveyors and 6 to 15 Plane-tablers ( including Topographical Trainees, Type ' B ' ) completed 1,160 square miles of air-cum-ground survey in Surat and Broach districts of Bombay and in Baroda State. The camp also completed air survey compilations of the Ukāi Dam site and Moj Commanded Area on the 32-inch and 4-inch scales respectively.

*Camp II.*—Mr. B. S. Chopra ( Surveyor ) with one Surveyor and 10 to 12 Plane-tablers ( including Topographical Trainees, Type ' B ' ) completed 1,633 square miles of blue print and air-cum-ground survey in Surat, Broach, Pānch Mahāls and West Khāndesh districts of Bombay and in Baroda State.

*Camp III.*—Mr. P. Ramamoorthy ( Class II Probationer ) with one Surveyor and 4 Plane-tablers completed 64 square miles of triangulation, 33 linear miles of traverse, a close network of tertiary levelling over an area of 63 square miles and 60 square miles of ground verification and contouring for the 4-inch air survey of the Moj Commanded Area in Saurāshtra.

commanded area of the Tungabhadra Project in the Raichūr district of Hyderābād State. During the field season of 1948-49 the party also completed planimetric control for the 16-inch air survey of the Kistna Dam site in the Kurnool district of Madras.

The political unrest in Hyderābād State in the latter part of 1948 had a slight adverse effect on the progress of survey. Not only was the opening of the field season slightly delayed, but even after political conditions had returned to normal, difficulties were experienced in obtaining local supplies of food, petrol and transport owing to the sudden change in the State administration.

The field headquarters of the party were at Raichūr.

104. **Personnel.**—The strength of the party was 1 Class I officer, 2 Class II officers, 7 to 10 Surveyors (Topographical Assistants) and 27 Topographical Trainees, Type 'B'. For field season 1948-49 this strength was reinforced by 18 more Topographical Trainees, Type 'B'.

105. **Areas Surveyed.**—

720 square miles of 4-inch original air survey of the Tungabhadra Project commanded area.

1,833 square miles of planimetric control for the 4-inch scale air survey of the Tungabhadra Project commanded area.

8 square miles of planimetric control for the 16-inch air survey of the Kistna Dam site.

1,721 square miles covered by a network of secondary and tertiary levelling and some traversing for the height control of the Tungabhadra Project commanded area.

106. **Field Work.**—The field work was organized as follows :—

(a) *Season 1947-48.—Traversing.*—A traverse detachment of 2 Surveyors (Topographical Assistants) completed 162 linear miles of theodolite traversing in Raichūr district of Hyderābād State.

*Levelling.*—Two levelling detachments consisting of three Surveyors (Topographical Assistants) and one Leveller completed 327 linear miles of secondary levelling in Raichūr district of Hyderābād State.

*Tertiary Levelling and Resection Camp.*—Mr. J. E. David (Class II) with 2 Surveyors (Topographical Assistants) and 20 Topographical Trainees, Type 'B', completed a tertiary levelling net over 761 square miles of the Tungabhadra commanded area in Raichūr district of Hyderābād State. This camp also simultaneously pin-pointed, by photo resection on air photographs of the area, all the bench-marks and pillars of the levelling net.

(b) *Season 1948-49.—Traversing.*—A traverse detachment consisting of 2 Surveyors (Topographical Assistants) completed 68 linear miles of Hunter's Short Base traversing in Raichūr district of Hyderābād State for the Tungabhadra commanded area. The

syllabus are given in Appendix to Technical Notes. Technical Report, 1948-49.

The party office opened at Bangalore in December 1947 with a strength of 39 trainees. Further recruitment of 21 trainees in May 1948 and 33 trainees in September 1948 was carried out. All recruitment was made through Regional Employment Exchanges. The Employment Exchanges were notified of the number of candidates required and the minimum qualifications a candidate should possess for appointment. Batches of candidates were then assembled by the Employment Exchanges at fixed centres where they were interviewed, tested and selected. The selection of candidates for appointment was made by Mr. J. C. Berry, the Officer in charge of the party. This procedure has resulted in obtaining a very good type of recruit with almost no necessity for weeding out after appointment.

110. **Personnel.**—The average strength of the party consisted of 1 Class I officer, 2 Class II officers, 3 Surveyors, 8 Plane-tablers as Instructors and 69 Topographical Trainees, Type 'B'.

Trainees of Nos. 10 and 17 Parties were cross posted in September 1948 and as a result of this 33 trainees were transferred to No. 17 Party and 17 trainees joined the unit from No. 17 Party.

A batch of 20 trainees with 2 Instructors were posted to the unit from Eastern Circle for a full course of training.

111. **Recess Work.**—Training during recess was carried out in and around Bangalore and consisted of theodolite traversing and computations, levelling and computations, preliminary air survey and fair drawing.

112. **Field Work.**—Training in the field was carried out in the Nandi Hills area, about 40 miles north of Bangalore, in the Kolar district of Mysore State. The first field season extended from November 1948 to April 1949. Training consisted of plane-tabling on the scale of 1,25,000. The trainees were grouped in three camps under the charge of Mr. I. K. Ponnappa (Class II) and Messrs. M. A. Azim and A. Francis (Surveyors) as Camp Officers. Each camp consisted of 23 trainees with 4 Instructors. At the conclusion of the plane-tabling course the trainees were put through a short course of interpretation of air photographs in the same area.

Mr. S. R. M. Louis (Class II Probationer) carried out triangulation of 280 square miles in the training area to provide supplementary framework for plane-tabling.

113. **Description of Country.**—The area selected for training comprised open and gently undulating country with sufficient prominence in the way of isolated rocky hillocks and spurs to provide training in the survey of hill features. The most prominent feature in the area was the Nandi Hills of which the main hill, Nandidrug, rises out of the plain to a height of 4,800 feet. The area

in the Kolar district of Mysore State. The headquarters of the party remained at Bangalore.

Field training consisted of plane-tableing on scales 1,25,000 and 1-inch to 1 mile.

The field camps were organized as follows :—

*Camp ( 1 ).*—31 trainees under Mr. I. K. Ponnappa ( Class II ), assisted by 5 Instructors.

*Camp ( 2 ).*—31 trainees under Mr. M. A. Azim ( Surveyor ), assisted by 5 Instructors.

Both camps successfully completed the plane-tableing courses on both scales, at the conclusion of which all trainees were put through a short course of interpretation of air photographs of the same area.

( b ) 1948-49.—In view of the prospective move of the party's permanent headquarters from Bangalore to Belgaum, the area for field training was selected about 30 miles south of Belgaum in parts of the Belgaum, Dhārwar and North Kanara districts of Bombay. The party headquarters remained at Bangalore and field headquarters were established at Belgaum. The field headquarters were located in the Argun Tank Lines where accommodation had been hired from the Army.

Field training was organized as follows :—

*Camp ( 1 ).*—Mr. J. A. Cabral ( Class II ) assisted by Mr. Y. D. Hegde ( Surveyor ) with 5 instructors and 26 trainees completed 1,627 square miles of 1-inch air-cum-ground survey in Belgaum, Dhārwar and North Kanara districts of Bombay. This was productive work and formed part of the field survey programme of Southern Circle for 1948-49. Air survey compilation and detail survey of this area had been carried out in recess 1948 by the same batch of trainees.

*Camp ( 2 ).*—Mr. M. N. Kutty ( Class II ) with 3 instructors and 21 trainees completed the training course of plane-tableing on scales 1,25,000 and 1-inch to 1 mile.

118. Description of Country.—For a description of the Nandi hills training area see No. 10 Party's report.

The training area south of Belgaum consisted of fairly hilly country covered by dense mixed forest in which bamboo predominated. The western part of the area extended up to the Goa boundary in the Western-Ghats and a characteristic feature of this portion of the area was the bareness of the more prominent hill tops. The whole area was well traversed by fair weather roads maintained by the Forest Department.

119. Recess Work 1948.—Training during recess 1948 was carried out in and around Bangalore.

The trainees were grouped in two sections :—

One section of 37 of the more advanced trainees, under Mr. M. N. Kutty ( Class II ), assisted by 3 instructors, took up the

## PART II.—MAP PUBLICATION AND OFFICE WORK

From 15th August 1947 to 31st March 1949

### VI. INTRODUCTION

121. *Progress of Map Publication.*—Index maps D to G, at the end of this report, show graphically the progress of publication to date of all standard series of modern maps, excluding those maps which are classified as “Restricted”, and are not available to the public.

122. *Work of Map Drawing and Printing Offices.*—The work of the drawing and printing offices of the Department for the period under report is described in three sections of Part II of this report, as follows :—

*Section VIII* ( page 62 ) gives statistics of map publications, extra-departmental printing undertaken and map issues.

*Section IX* ( page 67 ) describes the work of the drawing offices and includes two tables which quantitatively summarize this work.

*Section X* ( page 70 ) describes the work of the printing offices.

123. *Map Publication Policy.*—The period under report is of special significance as it immediately follows the partition of the country. This involved considerable transfers and changes of personnel, plant and equipment. The widespread disturbances during the early part of the period resulted in unusually heavy demands for printing maps for the army and all branches of Map Publication had to work on a war emergency basis in order to meet military requirements.

As a consequence the hopes for reversion to map publication in full pre-war colours had to be postponed, and the colour policy for the period under report remained practically the same as it was during the period of the previous report.

There were considerable demands on the Department for multi-colour lithographic printing for commercial firms and this work has become a regular feature of departmental activity. Apart from commercial work for private firms the Map Publication office has produced a large number of extra-departmental maps, booklets, brochures and posters in several colours. Owing to the difficulty of obtaining prompt publication of letterpress work, this Department has been called upon to reproduce lithographically a large number of books and pamphlets for Ministries of the Government of India.



*Asst. Manager—*

Mr. C. V. M. Hayman, from 5-1-48 to 30-4-48.

„ P. N. Kirpal, B.A., from 29-8-48 to 2-11-48.

„ P. K. Gupta, B.Sc., from 1-5-48.

*Electrical Engineer—*Mr. A. L. Sood.

*Photo-Zinco Office**Asst. Manager—*

Mr. P. N. Kirpal, B.A., to 2-11-48.

„ Bhagat Singh.

*Map Record & Issue Office*

( *Hathibarkala* )

*Chief Map Curator—( Temporary )—*

Mr. I. J. Mendes, to 29-2-48.

*Officer in charge—*

Mr. N. C. Nath, M.A., from 1-3-48.

Shillong. Director, Eastern

## Circle

Major R. T. L. Rogers, M.A., B.E., to 15-12-47.

„ R. S. Kalha, I.A., from 16-12-47 to 2-1-48.

„ I. H. R. Wilson, B.E., from 3-1-48 to 17-5-48.

Mr. B. N. Saha, M.Sc., from 18-5-48 to 9-11-48.

Major R. T. L. Rogers, M.A., B.E., from 10-11-48.

Calcutta. Deputy Director,

## Eastern Circle

Mr. B. N. Saha, M.Sc., to 1-9-47 and from 21-2-48 to 31-3-48.

Major R. S. Kalha, I.A., from 2-9-47 to 23-2-48.

Mr. C. P. E. Davenport, from 1-4-48 to 12-1-49 and from 17-2-49 to 12-3-49.

„ P. A. Thomas, from 13-1-49 to 16-2-49.

„ M. M. Ganapathy, B.A., from 13-3-49.

*No. 5 Drawing Office**Officer in charge—*

Mr. C. P. E. Davenport, to 27-9-47 and from 28-10-47 to 29-11-47.

„ L. J. Bagnall, B.Sc., from 28-9-47 to 27-10-47, from 5-1-48 to 16-2-49 and from 6-3-49.

„ N. L. Gupta, C.E., from 30-11-47 to 8-2-48 and from 1-3-48 to 4-4-48.

Mr. S. C. Chatterjee, B.Sc., from 9-2-48 to 29-2-48.

„ P. A. Thomas, from 17-2-49 to 5-3-49.

*Class II—Officer Surveyors—*

Mr. P. C. Sen Gupta, B.Sc.

„ S. C. Chatterjee, B.Sc., from 1-3-48 to 30-6-48.

„ L. J. Bagnall, B.Sc., from 17-2-49 to 5-3-49.

„ K. Sukhran Singh, B.A. ( Hons. ), from 1-11-47 to 29-2-49.

„ A. K. Sen Gupta, B.Sc., from 1-5-48 to 31-10-48.

*Class III—Surveyors—*

Mr. N. C. Nang.

„ S. K. Gulia, from 29-4-48.

„ L. R. Howard, from 28-3-48 to 30-10-48.

„ A. H. Sarkar, B.Sc., from 28-6-48 to 30-10-48.

„ A. K. Sarkar, B.Sc., from 5-7-48 to 5-11-48.

„ S. K. Dutta, B.Sc., from 5-7-48 to 30-10-48.

„ G. A. Ferns, from 5-7-48 to 22-10-48.

„ S. K. Ghose, B.Sc. ( Hons. ), from 5-7-48 to 5-11-48.

„ Kulwant Singh, B.Sc., from 9-7-48 to 6-10-48.

„ S. N. Roy, B.A. ( Hons. ), from 13-4-48 to 30-10-48.

„ G. S. Bagchi, to 14-12-47.

*Photo-Litho Office**Manager—*

Mr. K. L. Dey, to 20-8-48.

„ C. V. M. Hayman, from 1-9-48.

*Asst. Manager—*

Mr. C. V. M. Hayman, to 3-1-48.

„ G. Thomas, from 2-2-48.

*Map Record & Issue Office**Officer in charge—*

Mr. B. N. Saha, M.Sc., to 8-9-47 and from 10-11-47 to 29-2-48.

„ L. J. Bagnall, B.Sc., from 9-9-47 to 9-11-47.

„ A. K. Talapatra, B.A., from 1-3-48.

*Engraving Office**Head Engraver—*

Mr. G. J. Saha, to 7-11-47.

„ A. R. J. Dalziel, from 8-11-47.

*Asst. Head Engraver—*

Mr. G. J. Saha, from 8-11-47 to 21-9-48.

## VIII. PUBLICATIONS, EXTRA-DEPARTMENTAL PRINTING AND MAP ISSUES

124. Publications and Extra-departmental Printing.—The publications of the department during the period and printing done for other Government Departments and for the public are summarized in the following tables :

Table I ( *a* ) Departmental maps.

Table I ( *b* ) Extra-departmental maps.

Table I ( *c* ) Litho-printing, other than maps.

The progress made up to the end of the period under report in publication of the main series of topographical and geographical maps produced by the department is given in Table II. Table III shows the letterpress publications for the period.





Table III—( *concl'd.* )

12. Silviculture Research Code, Vol. II.
13. Index to Topo. Hand-Book X.
14. In addition to above, correction slips to Grid, Levelling and Survey Research Series Pamphlets, and Addenda and Corrigenda to Historical Records, Volume I, were published.

## (b) IN HAND AT DEHRA DUN

1. General Report 1946-47.
2. Technical Report 1946-47, Parts I and II.
3. Tide-Table Indian Ocean 1950.
4. Triangulation Pamphlet N H-38-F.
5. Auxiliary Tables, 6th Edition Part II ( Reprint ).
6. " " 7th Edition Part III ( Reprint ).
7. Tide-Table Bombay 1950.
8. " " Rangoon 1950.
9. " " Hooghly River 1950.
10. Topo. Hand-Book, Chapter I.
11. Historical Records, Vol. II.

## (c) PUBLISHED AT CALCUTTA

Several minor printing jobs, including that of Agmark Label Tobacco, were completed during the period under report.

## (d) IN HAND AT CALCUTTA

1. Agmark Label Tobacco.
2. Miscellaneous Departmental Forms, etc.
3. Alphabetical Index to Calcutta and Howrah Guide Map.
4. Half-tone Blocks.

## Out-turn of Letterpress Printing Sections

Section	Items of pages published	Copies printed	Impressions pulled
Dehra Dun ..	1,216	25,60,719	30,67,310
Calcutta ..	524	5,24,524	0,62,002
TOTAL ..	1,740	30,85,243	37,29,312

Table IV—Maps issued

	CENTRAL AND PROVINCIAL GOVERNMENT DEPARTMENTS			DEFENCE FORCES			PUBLIC			TOTAL			FURTHER ISSUES		
	Number of copies	Sale Value Rupees	Number of copies	Number of copies	Sale Value Rupees	Number of copies	Number of copies	Sale Value Rupees	Number of copies	Sale Value Rupees	Number of copies	Sale Value Rupees	Number of copies	Sale Value Rupees	Number of copies
<b>DEPARTMENTAL</b>															
Dehra Dūn ..	92,088	1,19,839	12,90,318	71,226	10,11,247	84,415	14,62,632	18,18,501	4,596	5,450					
Calcutta ..	13,711	50,860	7,18,520	24,904	2,69,145	31,560	7,87,165	3,51,805	36,807	39,046					
Shillong ..	918	1,039	48	1,247	54	1,452	2,243	2,545	1,534	1,712					
Bangalore ..	6,317	8,568	..	3,010	..	4,033	9,527	12,601	3,439	3,439					
Delhi ..	6,471	10,303	..	8,510	..	16,544	..	..	190	325					
Total (Departmental) ..	1,49,765	1,90,809	50,17,886	1,08,927	18,83,746	1,38,004	52,01,567	21,85,512	46,575	50,002					
<b>EXTRA-DEPARTMENTAL</b>															
Dehra Dūn ..	53,904	29,405	570	1,000	202	2,775	56,374	32,382	7,307	9,515					
Calcutta ..	13,67,851	1,44,052	24,055	46,064	9,020	30,040	14,37,970	1,92,112	11,035	12,295					
Shillong ..	8	21	..	..	..	..	8	24	..	..					
Bangalore ..	..	..	..	..	..	..	..	..	..	..					
Delhi ..	562	941	..	599	..	1,001	..	..	..	..					
Total (Extra-departmental) ..	14,92,265	1,71,425	24,625	48,473	9,222	42,816	14,94,352	2,24,518	19,002	21,840					
Grand Total ..	15,72,030	3,65,234	50,42,511	1,57,190	18,92,968	1,80,820	67,55,919	2,46,030	65,577	71,842					

Note:—(i) Total Mounting charges during the period....Rs. 63,652.  
(ii) 361,350 copies of Departmental maps and 32,249 copies of Extra-departmental maps issued on stock transfer.



(iv) 67-mile map of India showing Railways, corrected up to 30th September 1948.

127. No. 2 Drawing Office, Dehra Dun.—The main departmental work in this office during the period under report was new compilation of quarter-inch sheets and reissue of one-inch and quarter-inch sheets. Some sheets of Hind 5014 series on scale 1 : 500,000, were also prepared for the Defence Forces, India, in accordance with the specifications issued by Geographical Section, General Staff, A.H.Q., India.

Since the amalgamation of the Map Record Office of the Geodetic Branch with the Map Record and Issue Office of the Map Publication Directorate from 1st January 1949, this office took over the work of the Business Section of Northern Circle and is now responsible for the storage of all original records of departmental maps of Northern Circle and all records of Cantonment, Forest and Extra-departmental maps prepared in Northern Circle.

The Forest Map Office as such was abolished and attached to No. 2 Drawing Office as a separate section from October 1947. This section continued to meet all demands for forest maps from the contributing Provinces. In addition, paid-for work for non-contributing Provinces and States, and several Forest Maps for the Government of Burma were also completed.

128. No. 4 Drawing Office, Bangalore.—Apart from normal drawing work on departmental 1-inch and  $\frac{1}{2}$ -inch sheets, a section was entirely employed on minor projects and large scale town development maps compiled from air photographs.

The Maintenance and Record sections had to check and arrange a large number of original records received from other Directorates. The transfer of Records was due to the re-allocation of areas of regional responsibility. Maintenance work involved corrections to boundary as a result of the introduction of the integration and merger schemes.

129. No. 5 Drawing Office, Calcutta.—Besides the normal work of reissue and reprint of departmental  $\frac{1}{2}$ -inch and 1-inch maps respectively, this office also completed the following :—

- ( i ) Drawing of some sheets of Hind 5002 and 5014 series on scale 1 : 500,000 for the Defence Forces, India.
- ( ii ) Province map of Central India & Gwalior, Central Provinces & Berar, and Rajputana & Ajmer-Merwara on scale 1 : 1,000,000.
- ( iii ) Preparation of mosaics of Jamshedpur maps; Air cover Index for R.A.F. Assam, and Cinchona Research Station Kalimpong map, Plot A and B on scale 96 inches to 1 mile.

During the recess 6 Levellers and 12 Topo. trainees, Type 'B', were given preliminary training in drawing, plotting and projection, etc. 6 Surveyors were also trained in fair-mapping.



## X. WORK OF PRINTING OFFICES

132. Hathibarkala Photo-Litho Office (H.L.O.) Dehra Dūn.—  
In addition to normal departmental map publication, a large number of maps for political and defence purposes were printed during the period. Various kinds of lithographic printings, as cited below were also executed for other government departments :—

- ( i ) Pamphlets and Monthly Bulletins, Agmark Ghee and Butter labels were printed for the Ministries of Agriculture and Commerce.
- ( ii ) Maps, Drawings, Plans, etc., were reproduced for development schemes, such as Dam Projects, Road constructions and Civil Aviation.
- ( iii ) Graphs and Charts for the Industrial development were printed for the Director of Industrial Statistics.
- ( iv ) Posters, Brochures, etc., were printed for the Information & Broadcasting Ministry and the Chief of Air Staff, Air H.Q. India.
- ( v ) Postal forms, Railway diagrams, Electricity development scheme were also printed for different departments of the Government of India.
- ( vi ) A variety of work for the Development Schemes of the various States was also done.

Besides the above, a considerable amount of private jobs of educative value such as a World Atlas, Highway Code, etc., was also undertaken.

The following Printing Machines and proving Presses were in use :—

### *Lithographic Printing Machines :—*

- One Crabtree Fully Automatic Quad Demy Single Colour Offset with H.T.B. Feeder.
- One Crabtree Fully Automatic Quad Demy Double Colour Offset with H.T.B. Feeder.
- Three Crabtree Fully Automatic Double Demy Double Colour Offset with H.T.B. Feeder.
- One Crabtree Fully Automatic Double Demy Single Colour Offset with H.T.B. Feeder.
- One Mann Fast Three Fully Automatic Quad Demy Single Colour Offset with M.S. Feeder.
- One Mann Fast Five Fully Automatic Quad Demy Double Colour Offset with M.S. Feeder.
- One Mann Standard Double Demy Single Colour Offset Hand-fed.





One Crabtree Fully Automatic Double Demy Double Colour Offset with H.T.B. Feeder.  
 Two Mann Standard Double Demy Hand-fed Single Colour Offset with chain delivery.  
 Two Mann Double Demy Hand-fed Single Colour Offset with Chute delivery.  
 One Ratcliffe Quad Demy Flat-bed.  
 One Mann Double Elephant Flat-bed.

*Lithographic Proving Presses :—*

One Mann Quad Crown Offset Proving and Duplicating Press.  
 One Mann Quad Demy Offset Proving and Duplicating Press.  
 One Mann Double Demy Offset Proving and Duplicating Press.  
 Two Furnival Double Imperial Proving Presses.  
 Two Furnival Double Elephant Proving Presses.  
 One Greige Special Double Imperial Proving Press ( Hand Driven ).  
 One Hoe Double Imperial Proving Press ( Hand Driven ).  
 Two Hoe Double Elephant Proving Presses ( Hand Driven ).

*Letterpress Printing Machines :—*

One Dawson & Sons Double Demy Warfedale.  
 One Linotype & Machinery Double Crown Centurette.  
 One Rockstoreh & Schneider Foolscap Victoria Platen.  
 One Furnival Crown Folio Platen.  
 One Ruling Machine.

134. Photo-Zinco Office, Dehra Dūn.—The administrative control of this office was taken over by the Director, Map Publication from the Director, Geodetic Branch from 1st December 1947.

Apart from printing departmental maps, charts and diagrams, a fairly large number of extra-departmental maps, such as Cantonment maps, Projects maps, Forest maps including those of Burma, were printed during the period. The booklet "Forty trees common in India" and other Indian Forest Bulletin Leaflets for the Forest Research Institute and Fan Protractors for the Indian Ordnance Factory were also printed.

A total of 31 I.O.R.'s ( Indian other ranks ) were given training in different trades of map reproduction during the period under report. A new batch of 13 I.O.R.'s and one Junior Commissioned Officer have been under training since 14-2-49.

The following Printing Machines and Presses were in use :—

*Lithographic Printing Machines :—*

Two Crabtree Fully Automatic Double Demy Single Colour Offset with H.T.B. Feeder.  
 Three Crabtree Fully Automatic Double Demy Double Colour Offset with H.T.B. Feeder.  
 Two Mann Double Demy Single Colour Offset Hand-fed.

Table VIII—Out-turn and Cost of the Photo-Litho Offices

Name of Office	Maps printed (departmental and extra-departmental)	Work other than maps—Number of items	Number of Negatives prepared	Number of Zinc printing plates prepared	Number of impressions pulled	Value of out-turn at office rates	Total expenditure of the printing offices during year under report
<b>1. Dehra Dūn</b>						Rupees	Rupees
Map Publication Office							
(a) Hathi-barkala Litho Office	919	271	6,434	10,276	1,74,86,695	11,26,468	6,48,875
(b) Photo-Zinco Office	1,355	22	4,578	7,370	74,97,715	7,52,148	5,53,101
<b>2. Calcutta</b>							
Eastern Circle Photo-Litho Office	893	12	5,904	8,380	52,87,064	6,17,333	6,57,460
<b>Total</b>	<b>3,167</b>	<b>305</b>	<b>10,916</b>	<b>26,026</b>	<b>3,02,71,474</b>	<b>24,95,949</b>	<b>18,59,436</b>

Table IX—Out-turn of Process Engraving

Name of the Printing Office	Process Engraving Section			
	Half-tone Work		Line Work	
	Blocks prepared	Impressions pulled	Blocks prepared	Impressions pulled
<b>Dehra Dūn</b>				
Map Publication Office	Nil	Nil	Nil	Nil
<b>Calcutta</b>				
Eastern Circle ..	80	1,700	61	3,196

For impressions pulled see Table X.

## PART III.—GEODETIC WORK

### **XI. ABSTRACT OF GEODETIC OPERATIONS**

137. **General.**—Purely geodetic operations include miscellaneous computations and research, preparation and publication of records, observatory work (astronomical, magnetic, seismological and meteorological), measurement of geodetic bases, principal triangulation, geodetic levelling, precise latitudes, longitudes, azimuths, gravity determinations and prediction of tides at 39 ports between Suez and Singapore.

These operations were previously fully described in the annual Geodetic Reports of the Survey of India, but during the war no Geodetic Reports were published except for a short one for 1940, which placed on record only the most important items of geodetic work to safeguard against the risk of their being forgotten altogether. A complete account of all the geodetic work is now regularly published in Part III of the Technical Report. The first volume of this series is for 1947, which covers the period 1st October 1939 to 30th September 1947. The following is a brief account of the geodetic operations from 1st October 1947 to 31st March 1949. A fuller account is given in Technical Report 1948-49, Part III.

138. **Triangulation.**—The Primary and Secondary Triangulation of India which has often been loosely described as Geodetic was carried out between 1802 and 1882 when the skeleton framework of the geodetic triangulation was reckoned to be complete and the net was adjusted by simultaneous grinding for obtaining final values of co-ordinates—a process which took 20 years to complete. A number of secondary series was observed between 1909 and 1917 with a view to filling in the gaps between primary series and a vast amount of topographical triangulation was carried out to provide the framework for 1-inch maps. Very little has been done by way of primary triangulation since 1882 except a few series observed mainly in Baluchistan and Burma.

The precision of the existing topographical triangulation is generally not enough for providing a basis for surveys on scales larger than 1-inch and the geodetic framework was not at all designed for this purpose, its stations being located in remote and not easily accessible places. In the plains high tower stations were used and these have been mostly damaged or destroyed. No serious primary traverses have been run in India as a substitute for geodetic triangulation.

The strengthening and extension of the G.T. triangulation and the provision of a sufficiently dense and precise framework to provide scale and azimuth in areas where there is likelihood of large

continued. 16 pamphlets out of an estimated total of 76 have so far been published. Much progress, however, could not be made with the preparation of complete data triangulation pamphlets for India, due to lack of trained personnel.

144. Headquarters Routine.—The tidal predictions, the seismographical and the meteorological observations at Dehra Dūn have been carried out as usual. A touring tidal detachment carried out 29-day observations at 7 ports to provide data for improving the accuracy of tidal prediction.

para 177 ) and its main occupation during the period under report has been the training of computers, the supply of triangulation, traverse and levelling data; maintenance of progress charts of various field detachments, reprinting of auxiliary tables and professional forms, and the preparation of a second edition of certain levelling pamphlets. Some progress has also been made with the printing of triangulation pamphlets for Iran, but no progress could be made with the systematic adjustment of topographical triangulation all over India and its publication in pamphlets due to shortage of suitably trained personnel.

147. **Gravity Anomalies.**—The Mineral Adviser to the Government of India (now Director, Bureau of Mines) in consultation with the Geological Survey of India has suggested three priority areas which are considered to be economically productive:

The first area covers Raniganj coal-fields (about 70 miles in length and 40 miles in breadth), the second covers an area of about 20,000 sq. miles round Nagpur and the third, an area of about 340 miles in length and 90 miles in breadth near Belgáum. It is proposed to cover these areas by a 10-mile network of Gravimetric stations. The observations in the Raniganj area comprising of 30 stations have been completed. Observations have also been made at 76 stations in the Nagpur area where further work will be continued during the coming field season. Reduction of these observations and the calculations of the gravity anomalies according to the various hypothesis is a laborious job and is being carried out in the Computing Office.

148. **Levelling.**—The following lines of high precision levelling were carried out during the period under report :—

- ( i ) Ratnāgiri to Bombay in the back direction.
- ( ii ) Kolhāpur to Ratnāgiri in the back direction.
- ( iii ) Kolhāpur to Katwar in the fore direction.
- ( iv ) Raipur to Vizagapatam in the fore direction.
- ( v ) Burdwan to Diamond Harbour in both, back and fore directions.
- ( vi ) Diamond Harbour to Dublat in both, back and fore directions.
- ( vii ) Howrah to Jaleswar in fore direction.

Lines ( i ) to ( iv ) were carried out as part of the departmental programme for the new level net of high precision levelling and lines ( v ) to ( vii ) above were carried at the request of the River Surveyor to the Port of Calcutta for providing height datum for his Tide-Gauge stations.

Besides the above, secondary levelling from Hoshangābād to Mhow was carried out for height datums required by the Executive Engineer, Lower Narbada Division, for the Narbada and Tapi projects. The levelling was carried out both in the fore and back directions by sections of 8 miles, each section being subdivided in

stations for azimuth control of the triangulation series to which they belong.

Two detachments were formed during field season, one to determine the meridional deflection along longitude  $83^{\circ} 45'$  between Waltair and Dehri-on-Sone at 23 stations (including the two old latitude stations), and the other to determine both components of the deviation of the vertical and also to observe reciprocal azimuths at three pair of stations in Madhya Bhārat for obtaining reliable values of Prime Vertical deflections and corrections to triangulated azimuths.

The results are being computed in the Observatory Section.

### TIDAL SECTION

152. Tide-Tables.—The annual "Tide-Tables of the Indian Ocean" and the three separate pamphlets for Bombay, the Hooghly River and the Rangoon River for the year 1949 were prepared and published between July and September 1948. Advance predictions for the year 1949 and 1950 for a number of ports were sent in December 1947 and December 1948 respectively, to the Hydrographic Departments in England and the United States and to the Royal Indian Navy, as usual. At the request of Royal Indian Navy special tidal predictions for Rozi (in the gulf of Kutch) for the year 1948 were prepared and supplied, both in tables and chart form, on payment.

153. Tidal Observations.—Registrations with automatic gauges were continued by the port authorities at Aden, Karāchi, Bombay (Apollo-Bandar), Vizagapatam and Calcutta (Kidderpore). The Kent's Pneumatic gauge at Dublat (Saugor) which had to be shut down in September 1943 due to erosion of the foreshore had been re-installed by the Calcutta Port Commissioners in March 1944, and has since been working continuously. Three more self registering gauges of the Kent's Pneumatic type have been established by the Calcutta Port Commissioners during the recent years along the Hooghly, one at Gangra (established in April 1940 but destroyed by cyclone in October 1942 and re-installed in December 1942), another at Balari (established in August 1940) and the third at Diamond Harbour (established in January 1947). All these have been in operation during the period under report. Day-light observations of high and low waters on tide-poles were also continued at Bhāvnagar and Chittagong.

A programme of 29 days' systematic observations was carried out by a touring tidal detachment, newly formed in the Department, at a number of ports along the west coast of India during the field seasons 1947-48 and 1948-49.

---